THE CORNELL ENGINEER

May, 1944
Volume 9—Number 8

COLLEGE OF ENGINEERING · CORNELL UNIVERSITY

Taylor and White's great discovery which made possible high speed cutting was the greatest single development to help make mass production possible. The steel developed, commonly known as 18-4-1, served industry faithfully for over thirty years without a serious competitor.

In the early 1930's the first molybdenum high speed steels were used on a substantial commercial basis and, before the Second World War, about 25% of all tungsten high speed steels had already been replaced by molybdenum high speed steels on merit. This steady progress of logical replacement of the tungsten steels was interrupted by the war because of the tungsten shortage, when many industrial plants were forced to a sudden change to molybdenum steels.

Because of the stress of war production many concerns have never had an opportunity to satisfy themselves thoroughly as to the comparative merits of the molybdenum high speed steels. For those, in this category, who are inclined to return to the tungsten steels, we suggest a serious consideration of the following facts—molybdenum high speed steels perform as well as, or better than, tungsten steels—and they cost less.

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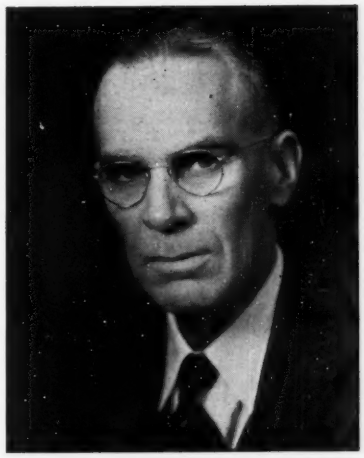
Power-Recovery System of Testing Aircraft Engines

By G. E. CASSIDY, M.E. '17

Industrial Engineering Department, General Electric Company



Mr. Cassidy

FOR its part in the development of the power-recovery system of testing aircraft engines, the electrical industry may properly take pride. It has helped the war effort by helping to give to the aircraft-engine industry a testing technique that contains advantages not previously available. In this system of testing, worth-while energy can be saved (more than half that required to operate an aircraft-engine-manufacturing plant) and power demand can be reduced to the extent that power-demand costs and the capacities of power-supplying apparatus are materially reduced. In addition, engines can be tested with the ease and the quietness typical of electrical machinery, testing can be carried on in buildings of simplified design, accurate electrical load readings can be obtained to check and substantiate readings taken by conventional engine-testing methods and, as reported by an aircraft-engine builder, testing may be accomplished more quickly than with other systems. All of this can be done on a basis that is economically sound.

General Electric's development of the power-recovery system of testing aircraft engines started in the fall of 1937 as a result of an inquiry from Pratt & Whitney Aircraft, Division of United Aircraft Corporation. In substance, Pratt & Whitney Aircraft asked: Can a system of testing be devised which will be economically efficient, which will make the loading of large engines easy and simple, and which will, at the same time, conform to the requirements of aircraft-engine testing?

THE AUTHOR

Mr. Cassidy was born in Honolulu in 1894. He graduated from Cornell in 1917, and the same year came to General Electric as a student engineer.

Two years later Mr. Cassidy joined the commercial engineering department of the International General Electric Co., and in 1923 became affiliated with G-E's Industrial Engineering Department. He worked on electrical equipment for rubber factories and cement plants, and in 1929 was transferred from Schenectady to the Fort Wayne, Indiana, works of the company.

Mr. Cassidy returned to Schenectady in 1936. In 1940 he was made engineer of the general applications section of the Industrial Engineering Division. Previously he had developed the power recovery system for testing aviation engines, beginning in 1937. The first installation was in 1940.

Extensive engine testing under loaded engine conditions has always been a necessary part of aircraft-engine *design and development* and a necessary part of regular every-day aircraft-engine *manufacture or production.* Such testing is necessary during development because new designs, either of complete engines or of engine parts, must be verified by test. Such testing is necessary during manufacture because it is by test only that each engine coming through production can be proven satisfactory and acceptable. The former class of testing, generally referred to as *laboratory or development* testing, is only of incidental interest in the present article. This development testing is generally accomplished by means of some form of cradled dynamometer or by means of such a dynamometer and a test stand on which the engine can be mounted and loaded by means of a propeller. The main issue and the real point of discussion is the latter form of testing, testing during manufacture, or what is commonly referred to as *production testing.*

Associated with production testing of aircraft engines, to such an intimate degree that it becomes an inherent part of this testing, is the breaking-in of the engine. When an engine is placed in an aircraft it must be ready to deliver its rated output. It must be ready to take off and fly.

Thus, for production testing of aircraft engines, the aircraft-engine

industry has always used testing techniques that involve several relatively lengthy loaded-engine operating periods during which an engine is simultaneously proven-in and broken-in.

In 1937 the only schemes used for production loading of aircraft engines were those involving propellers, water brakes, electric brakes, and similar devices. All of these involved disposal of engine power by complete wastage. The fuel consumed accomplished no useful purpose other than to permit testing the engine. Furthermore, engines were growing in size to the extent that testing schemes involving the disposition of power by wastage were beginning to present difficult problems.

The Pratt & Whitney Aircraft inquiry, therefore, led to the finding of a better and easier way to test aircraft engines and one in which the greater part of the power generated by the engine was recovered.

The first solution was a power-recovery system employing a synchronous machine with a slip-coupling.

Fig. 1 shows schematically the arrangement of this power-recovery stand. It consists of a synchronous machine, which acts as either a motor or generator, and a hydraulic slip-coupling interposed between the engine and the synchronous machine. Two such equipments were placed in operation at Pratt & Whitney Aircraft in the spring of 1940.

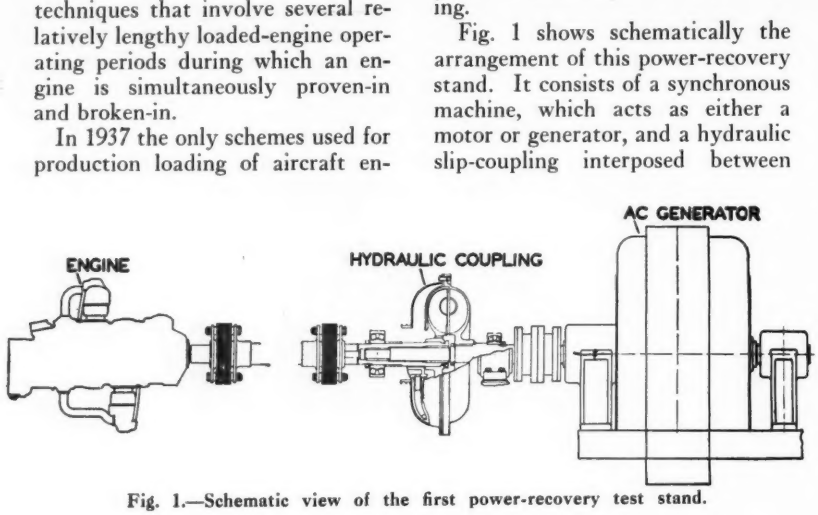


Fig. 1.—Schematic view of the first power-recovery test stand.

Slip-coupling Synchronous-machine Test Stand

It is self-evident that the only generally universal way usefully to dispose of the aircraft-engine output is to convert that output into electrical energy and dispose of the resulting electrical energy by making it available in the engine-plant electric-power mains. In other words, any universally applicable power-recovery system of testing must be an electric system and it must have as its foundation of operation an electric generator of one form or another.

In Fig. 1, the generator is a synchronous machine. It is equipped with an amortisseur winding and is started and connected to the line by being started at full voltage in the conventional synchronous-motor manner. During starting the coupling is set to transmit no torque so that the synchronous machine starts unloaded and the engine and engine half of the coupling remain at rest. After being connected to the line the synchronous machine functions as a motor or generator, depending upon whether mechanical energy is taken from it or delivered to it.

The synchronous machine operates at only one speed, synchronous speed, whereas the engine must operate over a range in speed. Furthermore, the synchronous machine will not control the loading of the engine. Within the limits of its capacity, it will deliver or absorb as much power as may be taken from it or delivered to it. Therefore by itself, it will not meet two basic engine-testing requirements, namely, the control of the speed and the control of the torque at which an engine is loaded. Accordingly, the slip-coupling is inserted and it is the function of the slip-coupling to provide these requirements.

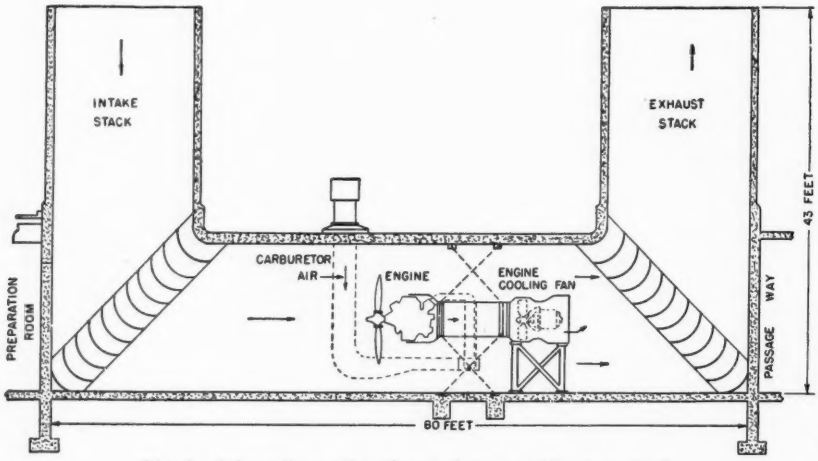


Fig. 2.—Schematic section of a modern propellor test stand.

Coupling Controlled

After the synchronous machine has been brought to speed and synchronized in the manner mentioned, the coupling is controlled to make the synchronous machine "turn over" the engine or run the engine mechanically. Then the engine is "fired" and, after it is warmed up, it is brought, by its own power, to a speed above that of the synchronous machine. The synchronous machine, then acting as a generator, loads the engine on the power system by slipping in the coupling. The amount and the speed of this loading are controlled by the engine throttle and the degree to which the coupling is energized.

It is interesting to note that in this application the hydraulic slip-coupling is used for the first time in a new role. Prior to its use here, it had been used either at low slip values or on drives with rapidly decreasing power with increase in slip, such as fan drives. In the engine-loading application, the power to be transmitted through the coupling increases, and increases

rapidly with increase in coupling slip.

In the fall of 1940, approximately six months after the original Pratt & Whitney Aircraft installation was placed in operation, the building of the first of three aircraft-engine plants to be erected by the automobile industry and using the power-recovery system of testing was initiated. For the purpose of this article, these engine plants can be designated as Plant No. 1, Plant No. 2 and Plant No. 3.

For the first, Plant No. 1, the synchronous-machine hydraulic-coupling scheme of testing was adopted.

Work on Plant No. 2 was started in the spring of 1941 and for this plant the same scheme of testing was adopted, except that magnetic slip-couplings of the eddy-current type were used instead of hydraulic couplings. A modification in the testing scheme, also, was incorporated with these magnetic couplings in that they are arranged for braking below synchronous speed, as will be explained presently.

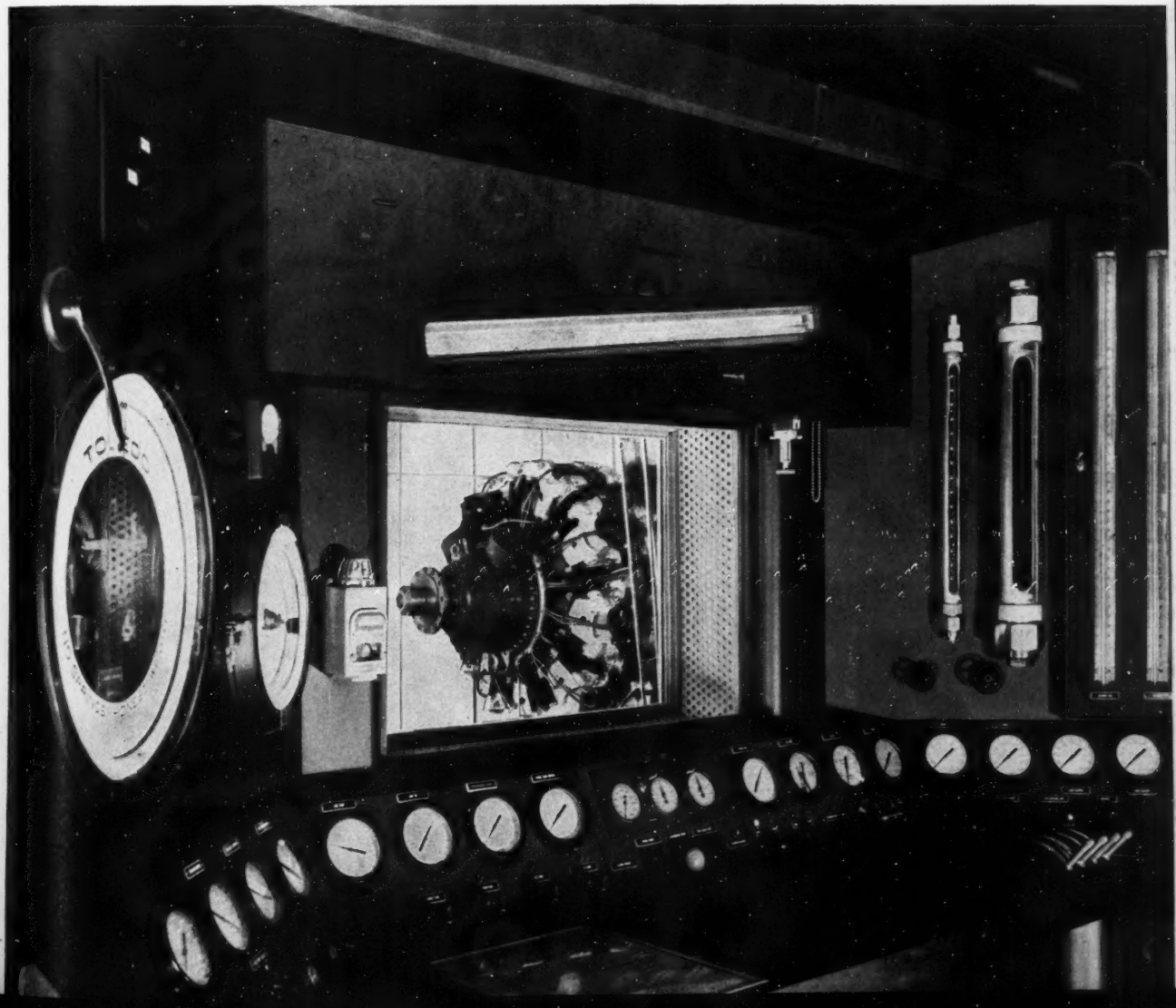
For Plant No. 3, the most recent of the three plants, another system of testing involving wound-rotor induction generators, was developed to meet the requirements of this installation. These induction test stands will be described later in the article.

Many Installations

There are now installed or on order for these various locations a large number of power-recovery testing equipments through which aircraft-engine production is or will be pushed. This total is a growing percentage of the total of all types of stands installed since the inception of the power-recovery system of testing. The equipments are made up of Westinghouse, Allis-Chalmers, or General Electric generators and, where used, Hydraulic Coupling Division of American Blower Corporation hydraulic couplings or Dynamic Corporation magnetic couplings.

The synchronous machine of Fig. 1 has a relatively high synchronous speed, a speed that is in the upper reaches of the engine speeds. This high speed is selected in order to minimize the loss in the coupling; this loss, as already stated, increases with increase in the difference between the engine and generator speeds. Also as stated, the engine cannot be loaded on the generator below synchronous speed, since at any engine speed below synchronous speed the synchronous machine will act as a motor. That is, the slip-coupling is a speed stepping-down and not a speed stepping-up device. Therefore, the selection of a high generator speed presupposes that an engine is ready to operate at this high speed before it is required to be loaded, that is, that it has been partially broken-in by mechanical operation possibly

Fig. 3.—An aircraft engine as viewed through the observation window of a test cell.



on the test stand itself, or possibly on a separate electric motor running-in stand.

At the Plant No. 2 installation an engine can be loaded below generator speed by loading on the magnetic coupling. To permit this the generator and generator half of the coupling are held stationary by means of a brake when the engine is operating below synchronous speed. In other words, below synchronous speed the magnetic coupling functions in the same manner as any eddy-current loading machine and above synchronous speed, with brake released and generator operating, it functions as a slip-coupling. The magnetic coupling is water cooled and, designed for the slipping operation, has inherently sufficient capacity for the braked operation. The fact is that loss of power under the braked conditions of operation is low. This is so because the engine outputs at low speed are low and the duration of the loading speeds is comparatively short.

Induction Generator Power-recovery System

While the Plant No. 2 installation was a modification of the original power-recovery unit which permitted loading an engine below synchronous speed by the addition of a brake, for the Plant No. 3 installation, still broader test-stand requirements were set up. For this installation it was desired not only to load the engine over its entire speed range but also to load the same engine in this manner equipped with gear-heads having three different ratios of speed reduction and consequently three different engine output shaft speeds. This requirement made necessary a test stand of considerably greater range of speed than previously used with the synchronous-machine slip-coupling stands, approximately 4:1 as compared with 1.5:1 or 2:1. Also, in this installation it was desired to eliminate the necessity of dissipating losses by means of cooling water, which requirement assumes increased importance in the light of the increased speed range of operation and consequently increased slip-loss.

These requirements pointed to a new type of stand, and, as mentioned, the wound-rotor induction-generator stand was accordingly developed.

As is well known the induction generator is a variable-speed machine with inherent characteristics similar to those of the conventional wound-rotor induction motor. In its application to the test stand, the electrical design of the induction machine is such that its synchronous speed corresponds approximately to the minimum loading speed of the engine. When the generator is connected to the power system and driven by the engine at any speed above its normal synchronous speed, the generator will pump part of the engine output into the power system as recovered power and the balance into the loading resistor as lost power. The proportions of these powers are the same as for the synchronous-machine slip-coupling stand.

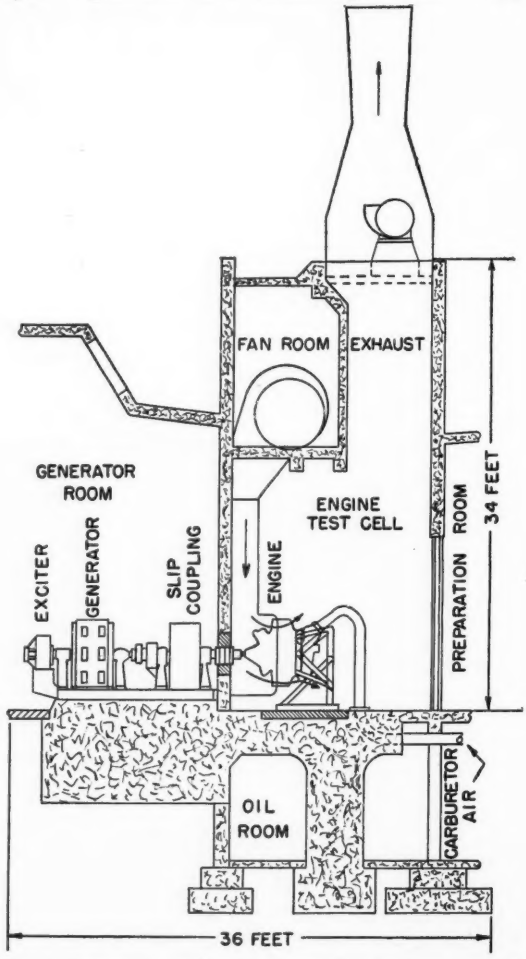


Fig. 4.—Schematic section of a power-recovery test stand of the synchronous-machine slip-coupling type.

With this wound-rotor induction-type stand the sequence of operation will be somewhat as follows: The first operation consists of a cold start and run-in test for testing mechanical operation and lubrication of the engine, the same as with the synchronous stand. This is done by starting up as an induction motor by secondary resistance control. After starting, speed is gradually increased up to approximately synchronous speed of the motor. When ready to "fire," the ignition switch is turned on and engine throttle adjusted for approximate idling speed. When ready to load, the throttle is opened, and, as the generator speed passes through synchronism, load is automatically applied to the engine. By the proper manipulation of the loading resistor and the engine throttle, any desired values of load and speed are then established and maintained.

Power Loss with Induction-generator Stand

One of the features of the induction-generator type of stand is the ease with which a high-loss loading element, the loading resistor, can be supplied and the ease with which high-loss power can be dissipated. Due to the wide range of operation the relative amount of power to be dissipated is considerable. For the more common present types of large engines equipped with the gear ratios mentioned, the loading resistor would have a maximum continuous rating of approximately 1200 kw. Using a resistor of the finned Calrod construction, it is a relatively simple matter to blow this energy into the air. With such a construction, no consideration need be given to the cost and availability of a suitable water-cooling

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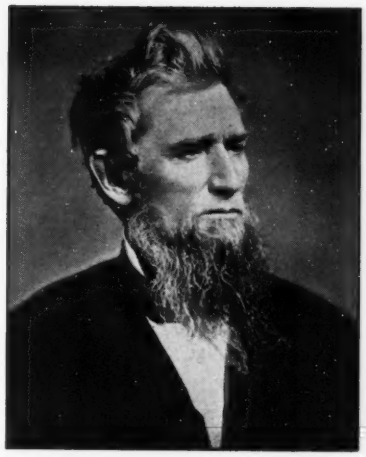
The Telegraph and Ezra Cornell -- 100 Years

By MORRIE S. HELITZER, EE '46



Ezra Cornell

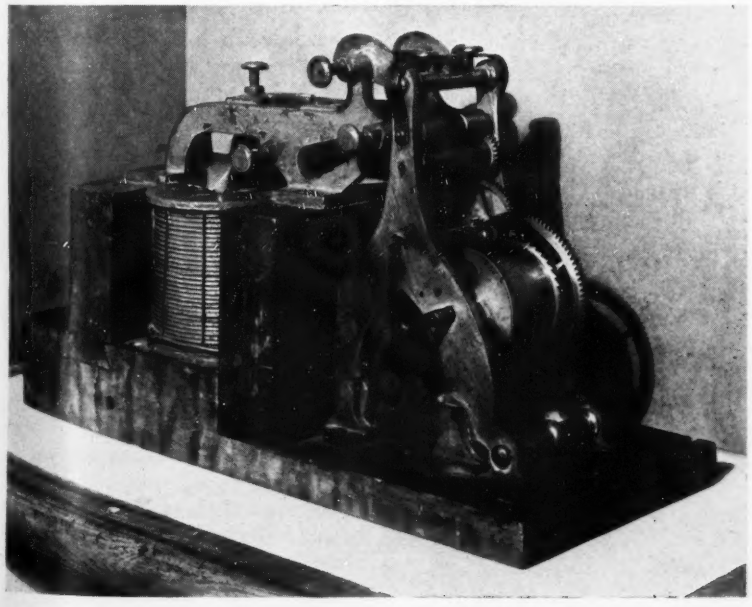
"WHAT Hath God Wrought?" As cameras grind and flash bulbs pop, the famous biblical words will be ticked out between Washington, D. C. and Baltimore, Md. and back. For it was 100 years ago this May 24, that Samuel Finley Breeze Morse sent that first message to Alfred Vail.

If Ezra Cornell were here today he would probably be as interested in the proceedings as he was 100 years ago. True, Professor Morse was the inventor of the telegraph; but without his "mechanical assistant", Ezra Cornell, the telegraph never could have been successful.

Cornell stumbled into the telegraph picture by a fanciful mistake. In Maine, he met a man who had the task of devising a plow for laying underground cable for the telegraph wires. He had reached the decision that it was necessary to have two plows to do the task; one, to lay the cable, and the other to cover the ground again. In a few minutes, Cornell's keenly practical mind had developed a scheme of employing one plow to perform both operations. His plan was adopted.

However, it seemed that success was not yet to smile on the fortunes of the telegraph or of Ezra Cornell. Some time after work had been proceeding, it was found that the telegraph would not work due to faulty insulation of the cable. In a move to allay public suspicion that they had hit a snag, Cornell drove the plow against a large boulder, thereby giving explanation to the cessation of work. When it was decided that an overhead system of strung wires upon poles with insulating supports was necessary, the question of insulation again posed itself. Henry Vail, a financial collaborator and associate of Morse's, proposed a plan, as did Ezra Cornell. Morse accepted Vail's plan but stopped off at Princeton to speak to his friend, Professor Henry. On being presented the problem, Henry gave his endorsement to Cornell's suggestion, which was promptly adopted.

Original telegraph receiver, owned by Cornell University



The type of insulation which was suggested by Cornell and incorporated into the instrument is described by John D. Reid in his book, "The Telegraph in America." The insulation consisted of "two plates of glass, between which the wire, after wrapping well with cloth, saturated with gum shellac, was placed, and over which a wooden cover to protect it from rain and press the glass upon the wire and keep it in its place was nailed."

Sponsoring the Centennial will be: Western Union Telegraph Co., Press Wireless Inc., International Tel. and Tel., R.C.A. Communication, Inc., American Tel. and Tel., and Tropical Radio Telephone.

Washington and the world will honor Samuel F. B. Morse and his invention on May 24. A plaque will be erected in his honor on that day; a commemoration stamp cele-

(Continued on page 40)

Zinc Yellow --- The Modern Metal Protective Pigment

By JOHN R. BORST, Chem.E. '42

Pigments Department, E. I. duPont de Nemours Co., Newark, N. J.

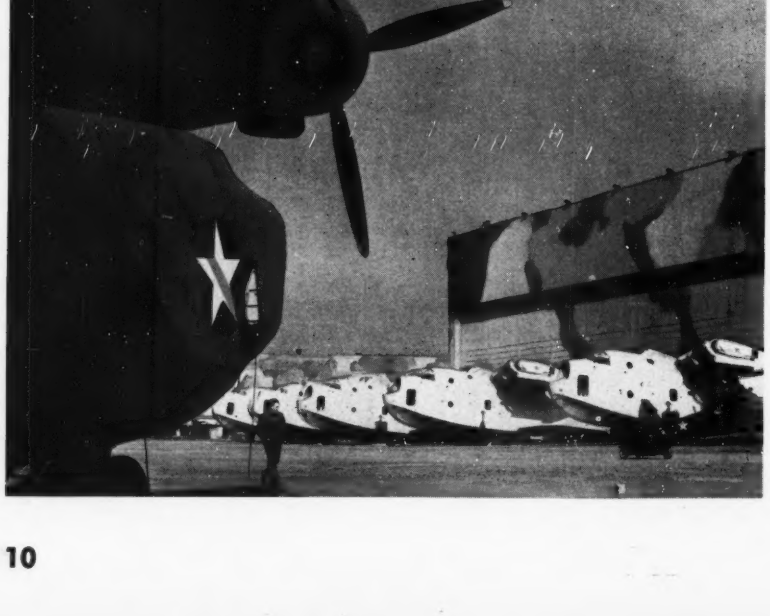
Mr. Borst

NEARLY all of us are familiar with the irregular patchwork of red lead on bridges and ships to protect these structures against corrosion. Red lead in linseed oil was considered the best rust inhibitor for a great many years and metallic surfaces were painted almost exclusively with it. Recently, however, the appearance of a bright canary yellow primer on both ferrous and non-ferrous surfaces has become much more common. The yellow pigment, zinc yellow, in this primer has proved not only to be a real rival of red lead as an anti-corrosive pigment but to have actually displaced the latter entirely for some purposes.

Few engineers have ever seen zinc yellow pigment, that is, the nearly insoluble, dry powder which is pale yellow in color. Rather, most of them have seen it in a primer or paint which is made by intimately mixing the dry powder with various liquid vehicles, generally of the oil type. This mixture forms a dry film when applied to the selected surface which serves to retard corrosive action. Both the vehicle and the pigment itself are responsible for the protective characteristics of the primer, but only the role of the pigment is to be considered in the discussion to follow.

These PBM patrol bombers are protected against salt water corrosion by a coating of zinc yellow primer.

Official U. S. Navy Photograph



The Composition of Zinc Yellow

Zinc yellow is often referred to as "zinc chromate". This designation is erroneous, if taken literally, since zinc yellow is not the simple zinc salt of chromic acid. In fact, the composition of the pigment is rather complex. The pigment contains not only zinc and chromium but also the element potassium. The best method of expressing the proportions of these elements in the complex salt is by means of the commonly accepted "oxide formula", $K_20{\cdot}4Zn0{\cdot}4Cr0_3{\cdot}3H_20$. According to this formula zinc yellow contains by weight approximately 11 per cent K_20, 37 per cent $Zn0$, 46 per cent $Cr0_3$ and 6 per cent combined water. It is a well known fact that sulfate ions introduced from the raw materials tend to replace an equivalent amount of chromate ions in the zinc yellow crystal and this may decrease the chromate content slightly from the amount given by the oxide formula.

The exact way that the elements or groups of elements in zinc yellow are bound together is still a matter of considerable speculation. The structure is such, however, that a basic compound of slight solubility in water results. These characteristics are desirable attributes from the standpoint of a corrosion-resisting pigment. Although the true function of the potassium is unknown, it is an established fact that the corresponding sodium analogue of zinc yellow is extremely soluble—so soluble, in fact, that it

possesses no usefulness as an anti-corrosive pigment.

Government specifications for zinc yellow pigment (AN-TT-Z-416) are such that the product in actual use for primers differs but little in composition from the oxide formula.

The Properties of Zinc Yellow

The properties of zinc yellow cannot be fully appreciated without knowing a few generalities about corrosion and how the properties of this pigment compare with others used for corrosion inhibition. Corrosion itself is a very complex phenomenon and although certain principles concerning its mechanism have been derived from experience with iron and steel, it has been found that these same principles are not always applicable to non-ferrous metals. The formulation of the electrochemical theory, which is now quite generally accepted, has been of great assistance in explaining corrosion phenomena. However, in spite of the derivation of a satisfactory explanation for the mechanics of corrosion, it has not been possible to perfect absolutely sure methods for preventing it.

Strides have been made in processing metal to render it corrosion resistant, notably in the formulation of the stainless steels, but surface treatment remains the economic expedient in major use. Protective coatings for metal are of two types—metallic coating, such as zinc, lead, nickel, tin, copper or chromium deposited by electroplating or other means, e.g., galvanized iron, and paint coatings. End uses of the protected metals dictate which of these two methods is the more economic. Paint is both practical and economic in a wide range of uses and for these it has become generally accepted.

All of these paint films contain one or more pigments which add to the protective value of the film. The function of these pigments is believed to be a specific inhibiting or passivating action at the surface of the metal. Naturally, the amount of protection offered by a paint film is dependent upon other factors than the pigment. Other considerations determining primer effectiveness include the type and condition of the metallic surface, type of vehicle in the film, thickness of the film, and ratio of pigment to vehicle. The pigments are imporant however, and may act in the primer in four ways—

to give, in conjunction with the vehicle, more or less impermeability to the film and minimize the passage of detrimental moisture and oxygen through the film to the metal—

to provide film impermeability, often as a result of flake-like structure —

to neutralize the acidic products from the decomposition of the vehicle by providing basic reactants—

to confer a definite passivating action on the metal because of certain soluble ions, such as chromate.

Red lead is incorporated in anti-corrosive primers because of its basic character and reactivity with linseed oil to form an impermeable paint film. This type of reaction is undesirable when it occurs in the package and, hence, is a disadvantage of red lead paint. Other drawbacks of red lead in oil are its high specific gravity and slow drying.

The properties of zinc yellow compare very favorably with those of its heavier competitor. Zinc yellow is basic in character and a source of passivating chromate ions. In oil, this pigment does not give as impervious a film as red lead but in other vehicles, for instance, some of the new synthetics, satisfactory impermeability is obtained. The use of zinc yellow in the newer vehicles has resulted in primers which are more flexible than red lead in the same vehicles, dry more rapidly, and possess better package stability. Needless to say, the lower specific gravity of zinc yellow (less than half of that of red lead) is greatly in its favor, especially in the aviation and marine fields.

Official Photograph, U. S. Army Air Forces

Applying camouflage paint over zinc yellow primer.

THE AUTHOR

John R. Borst entered Cornell University in 1937 from Phillips Exeter Academy, receiving a Bachelor of Chemistry degree in 1941 and a Chemical Engineer degree the following year.

Since his graduation he has been employed by the Du-Pont Company. He worked a few months on explosives. Then he changed to the Pigments Department where he is now engaged in the development and research work on colored pigments.

The Uses of Zinc Yellow

The numerous advantages of zinc yellow over red lead make its uses manifold. In the field of non-ferrous metals zinc yellow has achieved almost unopposed acceptance. Red lead primers were found to stimulate the corrosion of magnesium and alumninum alloys. Hence, the perfection of zinc yellow and the primers in which it is used have continued with the expansion of the aviation industry. To illustrate the effectiveness of zinc yellow for light metal alloys, one need only point to the use of the pigment in primers on all types of Army and Navy aircraft. The Navy alone used zinc yellow primer on over 15 thousand planes be-

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Tin Fish

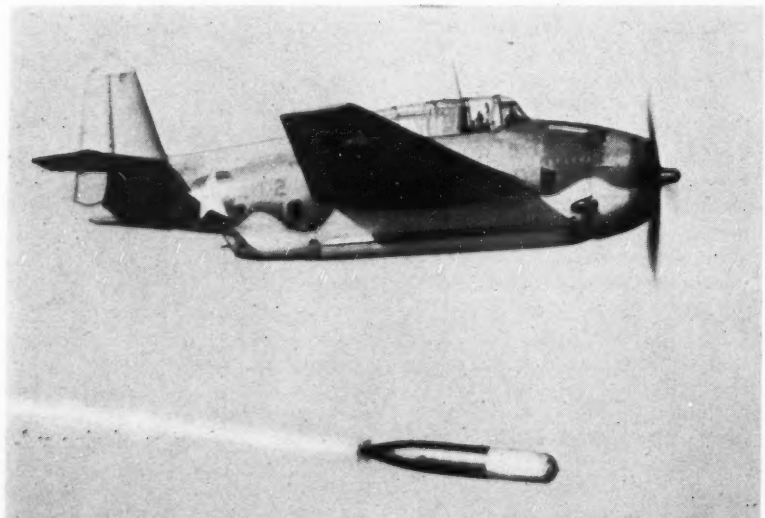
By Pvt. JAMES MAYER (ChemE '47)

THE modern torpedo is probably the deadliest and most effective weapon of this war. It contains more ingenious and complicated devices in its frame than any other projectile, but functions, except in rare circumstances, almost perfectly. This scourge of the seas varies in size from a fourteen inch diameter and fifteen foot length to a twenty-one inch diameter and twenty-one foot length. It is shaped in the form of a stubby cigar, weighs between 1,500 and 2,600 pounds, and costs from ten thousand to fourteen thousand dollars. The torpedo is known to have gone eight miles under its own power. Generating more than four hundred horse power, which is greater than the latest Ford V-8, it has a momentum of 65,000 foot-pounds per second. How does the torpedo achieve such power? The answer to this question can best be determined by examining its complicated structure.

The torpedo's 3,000 parts are packed into four sections. The first section is the warhead which contains from four hundred to six hundred pounds of TNT. The warhead is constructed of reinforced steel or bronze, but its outside shell is only seventy-five thousandths of an inch thick. This comprises the entire destructive force of the torpedo, and the remaining three sections are only to carry the warhead to its target. The mechanism that fires the charge from the warhead is slightly different for the German type of torpedo. In fact, torpedoes used by all the navies of the world are so much alike that this is the only appreciable difference between them. In the modern German torpedo the mechanism for exploding the TNT is exceedingly simple. When the torpedo, which is traveling at high speed, is stopped by a ship the resulting jar is enough to decompose a small amount of the unstable compound, fulminate of mercury. The resulting explosion sets off a small portion of TNT which is enough to explode the entire charge. This system of exploding charges, although it is very simple and probably the most efficient, is also very dangerous, for if the fulminate of mercury is not present in exactly the right amounts a very slight jar might be enough to set off the entire charge. In the other general type of torpedo, after the propellors which drive the projectile have made a certain number of revolutions, a striker bar is released and protrudes from the end of the torpedo. Upon contact with a vessel this bar is pushed back with sufficient force to strike a very small amount of fulminate of mercury and decompose it. The explosion sets off a primer charge of gun cotton, which in turn fires the full amount of TNT.

Skimming low over the water, a U. S. Navy TBF-1, Torpedo Bomber, cuts loose its lethal cargo.

Official U. S. Navy Photograph



In all types of torpedoes when the charge of high explosive is fired it creates a volume in gas of 17,000 times its own size. This is enough to cause considerable damage, but this great force has also been transmitted almost undiminished to the surrounding water. This force is also present in the surrounding water because of the pressure created from the increased volume. The resultant force, which is almost double the power of the TNT in air, is sufficient to rip huge holes in thick armor plate.

The second compartment of the torpedo and the section that takes up most of the torpedo's length—

about ten feet—is the air flask. The air flask is constructed of a specially built steel shell which can withstand a pressure of 5,000 pounds per square inch and contains compressed air at 2,250 pounds per square inch. This compressed air is used to operate all the devices contained in the torpedo and provides the power to run it.

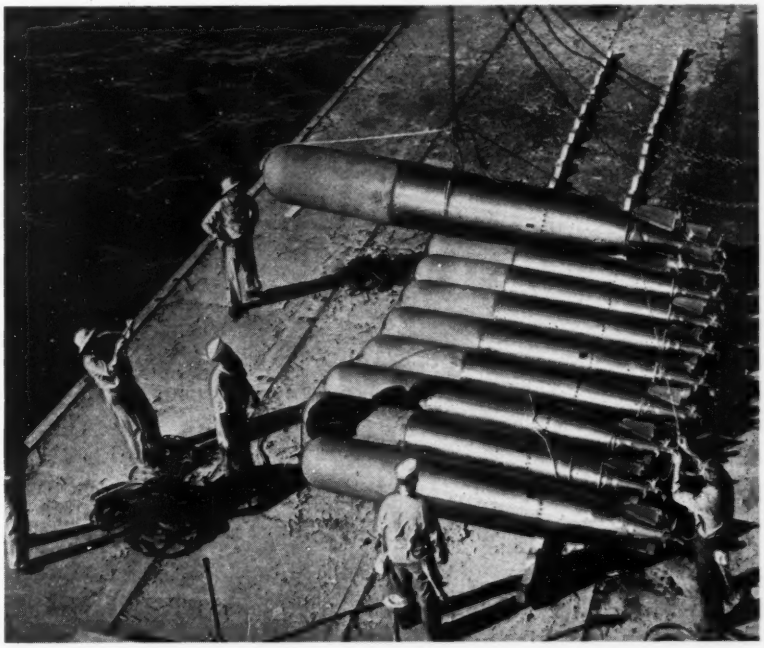
Third and Fourth Compartments

The third and fourth sections contain the implements to drive the torpedo forward and the means to keep it on its course. The third compartment contains fuel tanks of alcohol and water, the necessary lubricating oil, and the depth control mechanism. The depth control mechanism is an ingenious but relatively simple device consisting of a hydrostatic valve, a weighted pendulum, and a small motor. The hydrostatic valve is set for a certain water pressure; if the external water pressure upon the valve is too great or too small, it starts the motor to raise or lower the horizontal rudders (hydroplanes) until the desired depth is reached. The pendulum keeps the torpedo in a horizontal plane, after it has reached the right depth, by starting the motor if it is not in a perpendicular position. The hydrostatic valve also admits water into a small ballast chamber in order to compensate for the loss of weight in compressed air and fuel as the torpedo operates.

The fourth and final compartment contains the steering gear and the engines. The steering gear is simply a gyroscope set at a certain angle; it is kept constantly rotating at 18,000 revolutions a minute by a jet of compressed air from the air flask. This gyroscope is attached to a small air engine, which controls the vertical rudders. If the course is changed by rough seas or heavy currents, the gyroscope starts the air engine to turn the vertical rudders until the correct course is again taken. The gyroscope can also be adjusted so it will change angle at a certain distance and alter the torpedo's course. How this can be accomplished is apparently known only by United States naval engineers and is a heavily guarded secret. The twin engines on the modern torpedo are usually reciprocating, but the United States torpedoes have turbines. The horizontal and vertical rudders are in the tail of the torpedo and are not included in the fourth compartment.

The structure of the torpedo has now been examined, but nothing has been said about the functioning of its parts. Torpedos are launched from tubes which are of two types. The first type is used when the torpedo is projected beneath the surface. In this case the propelling force is compressed air, but, if the torpedo is launched above the water, a small charge of powder is used. Before the torpedo is sent on its journey, though, two things must first be done. The gyroscope must be set at a certain angle, and the depth must be adjusted by the hydrostatic valve. Both are set by a small numbered spindle on the side of the torpedo, the depth usually being about ten feet below the surface of the water, so that the torpedo is beneath the ship's armor belt. The instant a torpedo is launched, many things start to happen. A lever tripped by the forward motion lets a blast of compressed air into the combustion pot. Also, at the same time another jet of compressed air forces alcohol from the fuel tanks into the combustion pot. Operating on the same principle as the carburetor of an automobile, the combustion pot regulates the mixture of air and alcohol entering it. Two slow burning cartridges are now set off by the pressure in the combustion pot. These continue to burn and readily ignite the fuel, which is in the form of a highly inflammable spray of air and alcohol. Another jet of compressed air forces water from a self-regulating water pot on the fire, forming steam. The entire mixture of steam, gas, and compressed air is kept at a temperature of 1250 degrees Fahrenheit by a thermostat, which controls the amount of alcohol entering the combustion pot. This mixture now drives the counter-rotating turbines or reciprocating engines, generating enough power to drive the propellers to drive the torpedo at a speed of forty to fifty miles an hour. Two propellers are needed because one would drive the torpedo forward but it would also cause it to spin. Some energy would be lost, and the course could not be as accurate. So two counter-rotating propellers are used to keep the torpedo on an even keel. Although a torpedo can travel eight miles under its own power, its maximum usuable range is about a mile. The difficulty in getting correct direction and sufficient motivating power makes longer ranges impractical. In fact the lat-

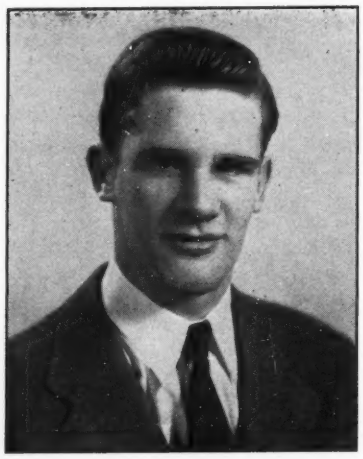
(Continued on page 26)



Official U. S. Navy Photograph

Torpedoes being carefully loaded aboard a ship somewhere in the South Pacific.

PROMINENT



Dick

Richard B. Hillman, ChemE

RICHARD Brace Hillman, more commonly known as Dick, was standing before the window of his third floor workroom in Olin Hall observing the co-oeds as they passed below on Central Avenue. He looked up quickly as we entered, then smiled warmly and said, "Yes, we have quite a view from this room."

Drawing up two chairs to his desk, Dick offered us one, settled down in the other, and began answering our queries in a thorough, unhurried manner. He had not answered many before it became quite evident that he has very little time nowadays to spend gazing out of windows. Dick's extra-curricular activities added to his tenth term Chem E. curriculum would be enough to keep an ordinary person busy thirty hours a day. But Dick is no ordinary person.

Before coming to Cornell, Dick had lived most of his life in Upper Darby, Pennsylvania. He attended Haverford High School near Philadelphia and walked off with at least a half dozen awards upon graduation. Aside from his regular studies, Dick played baritone horn in the school band and violin in the orchestra, acted in the senior play, and served as an editor of his yearbook.

It was in high school that Dick first became interested in chemistry. His recognition of the wonderful future for chemical engineering induced him to choose that branch of chemistry as his profession.

A visit to Cornell on a Sub-Frosh Weekend convinced Dick that this was the school for him. He began his studies here in September, 1940. An older sister had previously entered the College of Home Economics.

To attend school for eight consecutive terms without a summer vacation is no easy task, yet Dick has managed to do it. "I haven't had a vacation for so long," he explained, "that it would feel very strange if I were to get one now."

Dick's many and varied extra-curricular activities mark him as an outstanding Cornellian. Among other things, he is President of Willard Straight, a member of the Student Council, a student member of the University Board of Physical Education and Athletics, and a member of the American Institute of Chemical Engineers. He is also on the staff of the *Cornellian,*

(Continued on page 36)

Carlton Whitman, EE

OUTSTANDING among those who will receive degrees in Electrical Engineering this June is Carlton Whitman. Carl will have the distinction of being a member of the first group of engineers who completed their full eight terms of engineering in the record time of two and two-thirds years. This, as Carl observes, is a very short time for a college career. Yet, it has trained him for the important duties he will assume after his graduation and at the same time given him at least a chance to grasp at some of the broader opportunities offering themselves at Cornell.

Carl was immediately charmed by Cornell upon his "Cornell Day" visit to the campus in the spring of 1941. Interested in outing and hiking, he was especially drawn by the peculiar gorge formations found throughout the Finger Lakes region. Since his matriculation in the fall of 1941, Carl has explored many of the gorges in the Cayuga Lake region. He has found the topography of the area surrounding Ithaca most interesting for the pursuit of his favorite pastime. Behind this avid following of the camper's life there seems to lie a deeper purpose. For Carl well realizes that the engineering student's life, the indoor study and classroom work, is best complemented by healthy outdoor exercise.

The subject of classroom work brings to light a very interesting point. Carl is regarded by many of his fellow electrical engineers as a model student. This is by no means meant to intimate that he is the teachers pet or an apple polisher since he has no need to be such. His rapt attention in the classroom is given in a silence which is broken only rarely and then with astonishing results. Carl's classmates can not recall the time when some contribution he has made to a discussion has not shown clear thinking and forethought. For this he is respected.

In recognition of his scholastic attainments and general good fellowship, Carl has been honored. In his Junior year, he was elected by his classmates to serve on the Electrical Engineering Student Conduct Board. In the same year, he was elected to Eta Kappa Nu, national electrical engineering honor society. He has taken a great interest in this organization. Last summer, he originated the idea of collecting and reconditioning a group of electrical machines of historical interest. He investigated the possibilities of

Carl

making a permanent exhibit of the machines, called the "Stanley" equipment, and organized the program for setting up the exhibit. Work has progressed steadily to the point where the machinery is ready to be put on display in Franklin Hall. Meanwhile, Carl has become President of Eta Kappa Nu.

Carl is planning to enter Midshipman School this July. He will graduate after eight consecutive terms of concentrated activity. Doubtless, he will be remembered by the faculty of his school for his pleasant, efficient manner, and will be successful in his future Navy duties.

Robert Garmezy, ME-EE

WELL known to those who frequent the Engineering campus is the personage of Robert Garmezy. Indeed, the good humor which Bob radiates with a broad smile and a quick wit has permeated both Franklin and Sibley Halls. Bob is taking the ME-EE degree.

Geographically speaking, Bob has come a long way to study at Cornell. He was born and spent the first thirteen years of his life in Manila, in the Philippine Islands. To complete the last two years of his high school education, Bob came to the United States and settled in another relatively remote spot, Kansas. Here he perfected his three color separation technique for making color prints, dabbled in swimming and journalism, and meanwhile partook of the somewhat more advanced learning to be had at an American school. A humorously touchy subject with Bob seems to be the reason he chose Cornell. He tries to minimize the Hollywood impression of the Japanese engineer on the South Pacific island who grins and says "I studied at Cornell." Instead, he presents the much more plausible influence of his father, a loyal Cornellian of the Class of '13.

Bob

Bob entered Cornell in the fall of 1940. Since that time, his broad interests have led him to activities ranging from boxing to writing humor for the CORNELL ENGINEER. Truly, his list of extra-curricular enterprises is too long to fully set down in a brief article. When a freshman, while boxing was yet an intercollegiate sport at Cornell, Bob entered into competition in the manly art in the weight class of 127. At the end of his first year, Bob had earned a place on the Dean's Honor List, a position in which his name has remained for nine consecutive terms.

Living in Manila has its advantages claims Bob as he recalls his two-way clipper trip of the summer following his frosh year. The trip and the subsequent visit with his parents, delightful as it was, marked the end of vacations for Bob, for with his return to school in the fall of 1941, he took up the accelerated schedule.

Bob's honors began to arrive at the end of his junior year. He was elected to Eta Kappa Nu of which he later became vice-president, to the Cornell Day Engineering Council, and to the EE Student Conduct Committee. In his senior year, Bob was elected Chairman of the AIEE, to membership in the Delta Club, to Tau Beta Pi, of which he was later to become president, and finally to Phi Kappa Phi, the national scholastic honorary society.

Meanwhile, Bob had entered a new field of endeavor, teaching. His first experience came as an instructor in Physics 21 Laboratory during his senior year. At the end of

(Continued on page 36)

Bill

William J. Rothfuss, ChemE

ON occasions few and far between, Cornell has in its senior class a young man whose college distinctions read like a composite of the records of several of its most outstanding graduates. Bill Rothfuss is very definitely in this category. In scholarship, in student government, and in athletics, as a personality and as a leader, Bill Rothfuss has made extraordinary contributions to the life of the campus.

Bill was born in Mt. Vernon, New York. Shortly thereafter, the Rothfuss family moved to Plainfield, New Jersey, where they have remained ever since. By the time Bill reached his junior year in high school, he found himself mayor of Plainfield. Through no fault of his own, however, this only lasted for a day. Bill acquired the post as the result of a four-cornered election for the office in the local high school, defeating his three opponents, all of whom were seniors.

Bill spent his summer vacations at the family cottage at Bay Head along the Jersey coast. Bill's chief occupation in those days was sailing in his eighteen-foot sloop or fishing for tuna twenty miles off shore in a skiff.

Back home, Bill outfitted a chemical laboratory, occupying a considerable portion of the family cellar. One of Bill's less tasty experiments was the brewing of alcohol from molasses mash. Submitting to scientific curiosity, Bill sampled his homemade "Kentucky brew". According to his own testimony, he hasn't touched a drop

(Continued on page 34)

NEWS OF THE COLLEGE

New Navy Building

GROUND has been broken for the construction of a new temporary type building to house the ordnance materials and serve as a place for instruction for the U. S. Midshipmen School just established at the University.

The building is to be one story high resembling the Diesel School. It will be 152 feet long and 40 feet wide. The floor space will be entirely concrete while the lighting will be flourescent.

Four-fifths of the structure will consist of a mammoth gun shed. It will contain various types of secondary battery guns and several large models. It will also contain such miscellaneous equipment as control equipment, mines, torpedoes, and a spotting tank to determine the accuracy of shell-fire.

The rest of the building will be a night lookout trainer and a recognition section. The former will aid the students in the instant identification of friendly and enemy ships at night while the latter will teach daylight recognition.

The new buildings will be near classrooms and laboratories now used by the Navy, so its situation is an ideal one. The structure is expected to be finished about the end of May.

AIEE

ON Friday, March 24, Joseph Short, program director and production manager of WHCU, gave a short talk to the AIEE on broadcasting networks and radio production work. Following the talk, the monthly business meeting was held, and plans for a membership drive were made.

At the North Eastern District Technical Meeting of the A.I.E.E. held in Boston, April 19 and 20, the treasurer of the Cornell branch, AS Joseph E. Bambara, U.S.N.R., gave a talk on conducting student branch activities during wartime. Bambara, one of the top students in the EE school, is a member of Eta Kappa Nu, Delta Club, and Tau Beta Pi, and was recently elected to associate membership in Sigma Xi.

At the AIEE meeting held on April 27, two semi-technical movies were shown. "Steam Turbines" showed the construction and regulation of large power-generating turbines along with a simplified explanation of turbine theory. "Television" was a semi-technical movie which also presented some simplified theory.

Tau Beta Pi

NEW York Delta of Tau Beta Pi, national honorary engineering society, announces the election of the following new members:

Prof. E. M. Strong
Prof. J. O. Jeffrey
Prof. L. A Burckmyer
Fred Allen
W T. Duboc
J. P. Fraser
L. A. Gehorsam
L. A. Haines
C. C. Hansen
C. S. Hart
Charles Holmes
Daniel Hrtko
Lon Israel
F. H. Ludington
James MacDonald
N. J. Markason
Hugh Ogburn
Burton Preston
M. R. Rankin
B. H. Smith
George Swanson
W. H. Toole
David Wilkinson
Ferd Wascoe
R. C. Wolgast

Atmos

ATMOS held a meeting in conjunction with the faculty on April 28 in Willard Straight. Among the topics discussed was the honor system. The Cornell branch of A.S.M.E. held a meeting on Tuesday, May 2. A speaker from the Morse Chain Works addressed the group.

High Voltage Lab

CORNELL University's $150,000 High Voltage Research Laboratory, a cold-looking building from the outside but a wonderland of electrical magic on the inside, is functioning daily in research and the testing of commercial electrical apparatus.

Small companies which can not maintain their own specialized high-voltage laboratories and thus are unable to test for certain contract requirements for electrical equipment for customers, can make use of the laboratory to test insulators, bushings, switching devices, and transformers, and machines of a power system, when subjected to high-voltage surges due to lightning or other causes.

Two types of test equipment are maintained, sixty-cycle and impulse (lightning) voltages. The sixty cycle equipment consists of a bank of three transformers (combined output 750,000 volts, single phase; 433,000 volts, three phase) and power is supplied to the transformers by motor-generator sets rated to supply 650 kva. This gives sufficient test voltage for most transmission systems, but if need arises for a test voltage of one million volts, space is provided for a fourth transformer unit to be added later.

The impulse-voltage generator, or lightning maker, gives an output of three million volts—a voltage which duplicates that found in nature's lightning strokes to transformer systems. It tests electrical apparatus and insulating materials to determine if they can withstand these impacts of surge voltages created by nature.

Associate Professor M. L. Manning, formerly of Westinghouse Elec. and Mfg. Co., is director of the laboratory and of fundamental high-voltage research that will be implemented by these new facilities at Cornell. Assistant Professor M. M. Peterson, also formerly of Westinghouse, is chief operator in charge of testing, assisted by J.

N. Patterson, mechanician. Engineering faculty members and graduate students will use the laboratory for research.

Not only does the laboratory have a new lightning-voltage generator but it also has modern voltage measuring equipment including a cathode-ray oscillograph, a device capable of recording voltage variation during time intervals as short as two-tenths of one millionth of a second.

The building itself, on upper Mitchell Street, east of the campus, is all steel throughout. It is thermally insulated and is grounded and shielded where necessary to keep the effects of high voltage within the structure and to prevent radio interference in outlying areas. It is 62 x 122 feet and rises 71 feet to the peak of the roof, the equivalent of a six-story structure. For research purposes a high voltage transmission line one-half mile long is planned near the building.

Small offices, a shop, power room, furnace room, and a control room are located in one corner of the building. The remainder is one large room. For moving heavy equipment, there is provided a ten-ton crane, with automatic finger-tip control.

A spur of railroad track enters the property and ends in the main test area of the laboratory. Equipment sent by manufacturers may be tested directly on railway cars as shipped from the factory. Two large doors permit easy access. Although work in the laboratory often requires darkness, a flexible lighting system has been installed to provide a high intensity of illumination on the test floor when needed.

High-voltage work was pioneered at Cornell at the turn of the century by Professor H. J. Ryan (1888-1905). Professor Ryan designed some of the first high-voltage transformers in existence, and contributed numerous papers on high-voltage practice. Associated with him were Professors C. F. Harding and H. B. Smith, both successful in pioneering studies.

Dean S. C. Hollister of the College of Engineering points out that it seems particularly fitting that the work begun by these men should be carried on at Cornell in the new High-Voltage Laboratory.

Turkish Officers

SENT here by the Turkish Government on military scholarships, fourteen Turkish officers are studying mechanical engineering at Cornell. Headed by Nihat Cokyucel all of them are taking various phases of mechanical engineering in preparation for careers as industrial engineers in Turkish state-owned plants, which are largely military industries. Afterwards they expect to enter private practice. They are part of three contingents sent over to American colleges in the last four years for technical training.

The new group was selected by tests given to officers in the Turkish Army, and those chosen are undergraduates in the Sibley School. Formerly officers were sent to colleges on the continent, but the Army plans to send all men to the United States in the future.

Officers of the Turkish Army sent by their government to study mechanical engineering at Cornell. Shown left to right are Lieutenants Arif Cankatan, Mehmet Ali Oksal, Cemal Atay, Sami Gonul, Galip Arkilic, Ibrahim Taner, Nevzat Erkun, Resat Aynaoglu, Ibrahim Bunalay, Resat Saribas (only "veteran," former president of the Cosmopolitan Club), and Cavid Buyukmihci. Latest arrivals, not shown, are: Capt. Nihat Cokyucel and Lt. Fahrettin Swvak.

After finishing their work, the officers go back to Turkey to head Army industrial work in engineering.

ESMWT

FORMER Dean Dexter S. Kimball, professor emeritus of engineering, and Associate Professor C. I. Millard are active in the new "in service" courses of study in the Engineering, Science, and Management War Training program conducted by Cornell University in upstate cities. Lately, considerable emphasis has been placed on these new courses, which are given on company time to employees in industrial plants.

Teaching in these courses at Corning Glass Works, Dean Kimball is responsible for 12 lectures on industrial organization and management. The schedule calls for a period of morning and afternoon classes once a week for sixteen weeks.

Also at Corning, Professor Millard, who teaches industrial engineering at Cornell gives instruction on time and motion studies to the plant employees one day weekly, and in Buffalo he is responsible for similar instruction at the Ball Aircraft Corp., Curtiss-Wright, and the Buffalo Arms Co.

A newcomer to the regular ESMWT evening training courses is Associate Professor Harry J. Loberg, who has charge of a course concerning quality control on a statistical basis. The class is held in Binghamton.

Total enrollment in Cornell University's spring program of Engineering, Science, and Management War Training courses in 10 upstate cities is now 1930.

ALUMNI NEWS

Annual Meeting

THE Annual Meeting of the Cornell Society of Engineers took place on May 1st at the Cornell Club of New York. The Nominating Committee, composed of George N. Brown, Chairman, John P. Riley and Lawrence Waterbury, presented the following nominees who were duly elected:

President, Bernard A. Savage '25

Executive Vice President, J. Paul Leinroth '12

Secretary-Treasurer, Paul O. Reyneau '13

Recording Secretary, William M. Reck '14

Their term of office runs from June 1, 1944 to May 31, 1945.

The speakers at the meeting were: Dean Hollister, who brought up to date minute news on happenings at Ithaca; L. A. (Jake) Swirbul '20, Vice President and General Manager of Grumman Aircraft, told of his recent trip in which he witnessed the landing on Kwajalein Island, in the Marshalls, and showed his own sound motion pictures of the battles of Tarawa and Kwapalein; E.E. (Swede) Lareson, former head football coach at Annapolis and now Colonel of Marines, just returned from twenty-two months in the Pacific spoke of developments in that theatre and emphasized the fine morale of our fighting men at the high quality of our leadership. The attendance at the meeting was about 150.

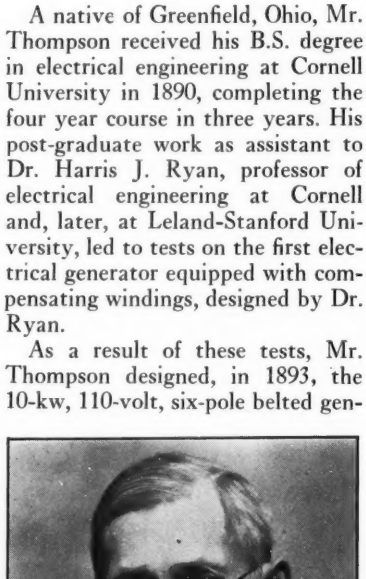
M.E. Thompson, E.E. '90

M. E. Thompson, electrical industry pioneer, inventor, and father of the compensated generator, died at his home in Ridgway, Pa., April 5th at the age of 80, after a long illness due to a heart condition.

Oldest employee on the active list of the Ridgway Division, Elliott Company, Mr. Thompson was employed as consulting engineer for Elliott Company at the time of his death. He has previously been chief engineer of the Ridgway plant.

A native of Greenfield, Ohio, Mr. Thompson received his B.S. degree in electrical engineering at Cornell University in 1890, completing the four year course in three years. His post-graduate work as assistant to Dr. Harris J. Ryan, professor of electrical engineering at Cornell and, later, at Leland-Stanford University, led to tests on the first electrical generator equipped with compensating windings, designed by Dr. Ryan.

As a result of these tests, Mr. Thompson designed, in 1893, the 10-kw, 110-volt, six-pole belted gen-



M. E. Thompson

erator now displayed in the Edison Institute at Dearborn, Michigan. This Thompson-Ryan machine carries a card reading "This is the first generator ever built having compensated winding and commutating poles."

Necessary modifications of this machine lead Mr. Thompson to invent, within a few hours of its first test run, a combination of commutating pole and compensating winding, with the latter carried by a continuous ring separate from the rest of the field structure. He thus first established the fact that the compensating winding could perform a two-fold function in creating a fixed and properly proportioned commutating field for all load conditions, and in preventing distortion of the main field by armature reaction.

All commercial generators of the compensated type since built in this country and abroad have embodied this double feature of the compensating winding, invented by Mr. Thompson.

While still a student at Cornell, Mr. Thompson also invented the first practical alternating-current watt-hour meter of the motor type, involving the same general principle used in such meters today. In addition, he made an exhaustive study of the magnetic properties of iron and steel.

In addition to discoveries which revolutionized the infant electrical power industry by increasing the practicability and commercial value of direct current generators and motors, Mr. Thompson made many other contributions to the design of steam engines and other power plant equipment. As early as World War I, he was a pioneer in the development of electrical propulsion equipment for submarines of the U. S. Navy, and held the esteem and trust of many high-ranking officials of that service.

The Ridgway Division of Elliott Company was a major interest in Mr. Thompson's life. His training and assistance were of special value to younger engineers, and his help in the problems of electrical design, and in the techniques of electrical and mechanical engineering, was a substantial aid in the development and growth of the company. Mr. Thompson leaves his widow, the former Marion McCann, and a daughter, Mrs. A. T. Kelley, of Toledo. A sister, Mrs. Anthony Sharp of Terre Haute, Ind., and a grandson also survive.

Nominations

THREE Cornell engineering graduates are among those nominated for alumni trustees, for possible election next June 26 for five-year terms. Official ballots, which were distributed to all Cornell degree holders, are to be returned to the

Treasurer by June 19. The results will be announced at the Alumni Association meeting on June 24.

Among the nominees is George C. Brainard M.E. '11, president of General Fireproofing Co., Youngstown, Ohio. He is Chairman of the Board of the Federal Reserve Bank of Cleveland and a director of Youngstown Sheet & Tube Co., Youngstown Municipal Railway, and the Youngstown & Ashtabula Railroad. In 1942, he was a "dollar-a-year man" in Washington, as director of the tools division and deputy director of production, War Production Board. Brainard entered Sibley College from Northwestern University in 1907.

Mathew Carey, C.E. '15, is head of the firm of Matthew Carey and Co., Detroit, Mich., dealers in municipal bonds and consultants on municipal finance. Secretary of the Class of 1915, Carey has been vice-president of the Alumni Fund Council since 1941 and an alumni trustee since 1939. As an undergraduate in Civil Engineering, Carey carried a New York State Scholarship, was elected to Tau Beta Pi, and represented non-fraternity men on the committee which organized the first Student Council.

Joseph P. Ripley, M.E. '12, is chairman of the investment banking firm of Harriman, Ripley and Co., Inc., New York City. Ripley entered Sibley College in 1908 and received the ME degree in 1912. He won the Sibley Prize and was elected to Tau Beta Pi. He has been a member of the Joint Administrative Board of the New York Hospital, Cornell Medical College Association since 1942.

Directors of N.A.M.

Five Cornellians are members of the board of directors of the National Association of Manufacturers. Three of them are graduates of the school of mechanical engineering; Charles R. Cook, '07, president of Cook Paint and Varnish Co., Kansas City, Mo.; University Trustee John L. Collyer '17, president of B. F. Goodrich Co., Akron, Ohio; and Norman E. Elsas, '18, president of the Fulton Bag and Cotton Mills, Atlanta, Ga. Raleigh Hortenstine, president of Wyatt Metal and Boiler Works, Dallas, Texas, a member of the class of 1910 in civil engineering and Alfred W. Bames, president of the California Packing Corp., San Francisco, Cal., who graduated from the College of Arts and Sciences in 1911 are the other two.

A. M. Hamilton, M.E. '09

Alexander M. Hamilton, M.E. '09, has been named vice president in charge of foreign sales for the American Locomotive Company. Mr. Hamilton, a native of Schenectady, was formerly executive vice-president of Montreal Locomotive Works, Ltd., Canadian subsidiary of the American Locomotive Company.

Gen. C. D. Young, M.E. '02

Brig. General Charles D. Young M.E. '02, is acting director of the Office of Defense Transportation by appointment of President Roosevelt. He has been associated with the ODT since soon after its establishment on Dec. 18, 1941, and has been its deputy director for more than a year. General Young will serve until a successor to the late Joseph B. Eastman is named.

Born in Washington in 1878, he served in the Navy during the Spanish-American War. In 1900 he started to work for the Pennsylvania Railroad, and has continued ever since except for periods of Army and government assignments in both the first World War and the present war.

After holding various positions in the operating and mechanical departments of the Pennsylvania Railroad, he became vice president in charge of purchases, stores, and insurance in 1932 and assumed the added duties of vice president in charge of real estate and taxation in 1938.

In the first World War he served with the Army Transportation Corps, and held a position in the Engineer Corps Reserve. On Jan. 14, 1942, Eastman, Director of the ODT, appointed him to his staff as director of the section for materials and equipment. The following month, General Young left for active service with the supply division of the War Department General Staff, but in July, 1942, was placed in an inactive status after reaching the Army retirement age, and returned to the ODT as assistant director.

While at Cornell, General Young competed in the sprints and broad jump and in his senior year was captain of the track team. His home is in Philadelphia. Many times when Cornell track teams have been in Philadelphia, he has visited them showing a continued interest in the sport in which he excelled while at Cornell.

W. R. Turnbull, M.E. '93

Rupert Turnbull '93 has for the past twenty-five years been formulating plans to build dams in the Bay of Fundy in New Brunswick to harness its thirty-five foot tides to generate an estimated 400,000 horsepower. The Harbors Committee of the Canadian Senate has now decided to investigate the proposed project, "Time" magazine has reported.

Turnbull was born in New Brunswick. After graduating from Cornell in 1893, he studied at Heidelberg. Upon his return to the United States, he obtained a position with General Electric but soon went back to New Brunswick to experiment in the then new science of aerodynamics. He built Canada's first wind tunnel and did a great deal of work in aircraft propellor design. Curtiss-Wright in the United States and the Bristol Aeroplane Co. in England are now utilizing his developments on an electric controllable-pitch propellor.

Cornell University Placement Service

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"Loose Juice"

Collected by Bob Garmezy

News Item

It seems that the men's room in Olin Hall is completely devoid of the usual lavatory inscriptions. It is to be wondered whether the Chem Engineers are illiterate and uninspired, or whether they never use the men's room. When questioned, one of the ChemE's furtively mentioned Dusty's name and hurried off. In regard to this matter of inscriptions, we must concede the dubious honor of first place to Lincoln Hall. This is probably due to its early date of erection which has allowed the art to reach a higher peak of perfection than in other schools.

* * *

A Chinese Romance

Nice night	Honeymoon
In June	Everything.
Stars bright	
Big moon	Another night
In park	In June
On bench	Stars bright
With girl	Big moon
In clinch	No more happy
Me say	Carry baby
Me love	Walk floor
She coo	Wife mad
Like dove	She fuss
Me smart	Me mad
Me fast	Me cuss
Never first	Life one
Chance pass	Big spat
Get hitched	Nagging wife
Me say	Babbling brat
She say	Realize
O. K.	At last
Wedding bells	Me too
Ring! Ring!	Damn fast.

* * *

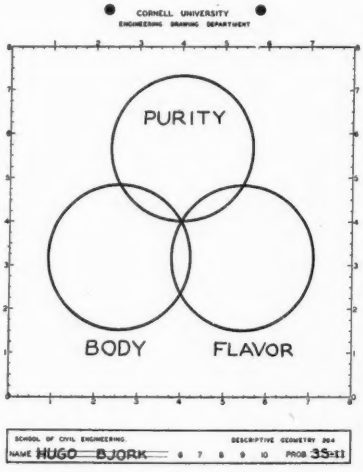
To The Widow

In the first issue of the resurrected Widow, the lady in black made an unkind statement about the ENGINEER in regard to Timken roller bearings. We quote " . . . It is really heartening to know that when this bloody conflict is at last over, our boys will return to find peace on earth and Timken tapered roller bearings enough for all." We wish to point out that, no matter how one looks at it, returning to a world of Timken roller bearings is much better than coming back to a world of widows.

To Professor J. O. Jeffrey

In Materials 3T21 Prof. Jeffrey, after relating some interesting and unusual fact, sometimes calls for a show of hands from those who have previously heard said fact. We would like to inform Prof. Jeffrey that the amazing show of hands is due to a very high percentage of repeaters, and that his facts are really astounding when heard for the first time.

Hugo Bjork



One of Hugo's plates

WHO is Bjork? Or to be more formal, who is Hugo Roscoe Bjork (pronounced Bee-ork). For over two months now this question has bothered many people. That there is such a person there can be no doubt—but nobody will swear by the honor code or any handbook to have seen him.

This elusive character first made himself known to the CE Class of '47 on Wednesday, March 7, when on the class roll for Geology 501 was found the name, "Bjork, Hugo." No one in the class recalled this name. Therefore it was feared that he was an architect, or some other lost soul. But Bjork was found registered in other CE courses. As he was exceedingly delinquent in his attendance, the students were convinced he was legitimate, a CE. However, Bjork's homework was handed in daily despite his absence, and no one was seen in the act. This led the class to wonder: Who is this versatile Hugo Bjork?

Perhaps the mystery of his absence would have been solved when the following article was found in the Personal Notes of the Syracuse *Post-Standard,* Thursday, March 16:

"Hugo R. Bjork of the School of Civil Engineering at Cornell University has returned to Ithaca after a visit to some friend and attending a seminar in geology."

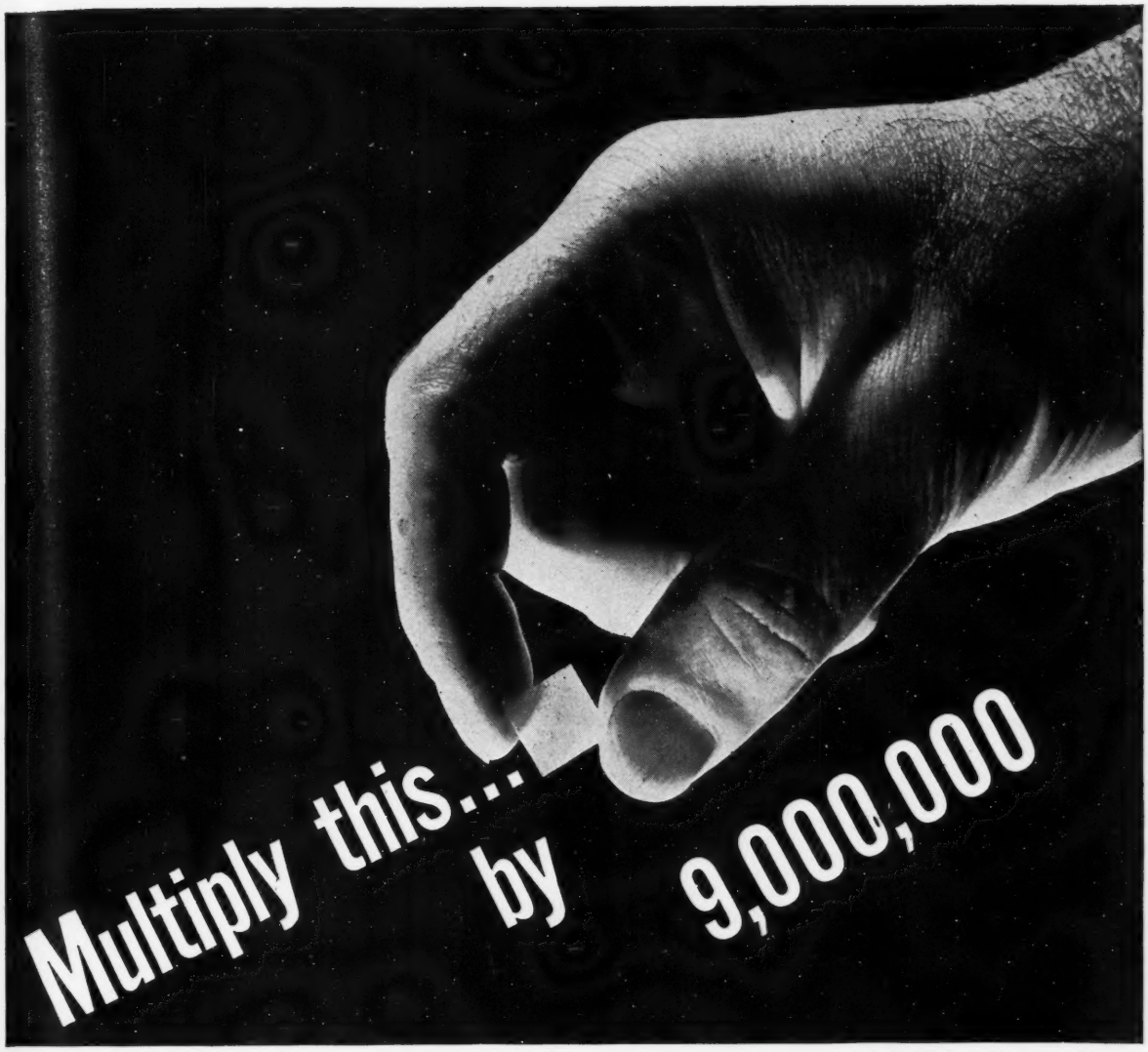
When Bjork was still not seen in class, the CE's were puzzled. In fact, some of the less restrained members of the class and one sailor admitted extreme bafflement.

Complications grew and grew. Bjork began leaving a horrible trail of destruction, beginning with the geology lab fee of $4.50. That small sum and the efficiency of the Treasurer's Office soon unearthed some miscalculation in the records. Several members of the class received phone calls from someone purporting to be from Mr. Rogalsky's office asking them to contact our Hugo and have him drop in and straighten his accounts. Once again Bjork's ugly head popped up (Ed. Note: The CE class can offer no substantiation to the claims that Bjork's head is ugly or that it comes to a point on top). He made an appointment with Mr. Rogalsky's secretary for 2:30 that Saturday. The following Monday a gentleman identifying himself as Mr. Rogalsky phoned Hugo again in reference to the broken appointment. Bjork is reported to have answered, "Tough."

This matter was evidently referred to Dean Betten's attention, as a card from his office was received ordering Bjork to appear before him immediately. No further developments have been reported from that quarter.

Though he did not deem Mechanics recitation (an 8 o'clock)

(Continued on page 38)



. . . a wartime problem in Engineering

THIS is a quartz crystal. Its job is to hold an airplane or tank radio exactly on its assigned wave length—so fighting men can get messages through quickly, clearly.

Under pressure of war's demands for immense quantities of radio equipment, Western Electric engineers have helped to revolutionize crystal production techniques. Consider these problems:

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Each one is mounted on wires so small that many operations and inspections must be performed under a microscope.

Amazing new machines and methods were devised to do such jobs quickly and well—and the crystals are turned out in unprecedented numbers. One of our four shops now makes as many crystals in a day as the entire industry used to make in a year! To date, Western Electric has produced more than 9,000,000 crystals for war.

Mass production of crystals is just one of many fascinating problems that have been and are being solved by engineers at Western Electric—the nation's largest producer of electronic and communications equipment for war.

To speed Victory, buy War Bonds regularly—all you can!

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IN WAR.. ARSENAL OF COMMUNICATIONS EQUIPMENT.

PUBLICATIONS

Fluid Mechanics by R. C. Binder, Prentice Hall, 307 pp, 1944, $3.75

Professor R. C. Binder of Purdue University has, in this book, supplied a commendable elementary text on fluid mechanics. This text should help the undergraduate student bridge the gap which has so long existed between the vast amount of empirical data collected and studied under the name of hydraulics and the imposing mass of applied mathematics built up under the name of hydromechanics. This latter branch of science has long been neglected by the engineer because of the mathematics involved. Only recently have the results of laboratory research and the reasoning of hydromechanics been correlated to offer usable material for the engineer.

Hydraulics, based on the empirical studies of flowing water, supplies only part of the information needed in present-day work. The modern engineer has many problems in which the flow of liquids and gases other than water must be considered. An understanding of the various fluid flow phenomena based on general physical laws together with the physical properties of the fluid are now a necessary part of an engineer's education. A much broader field of application is to be gained by considering these phenomena from the mechanics viewpoint rather than by our older empirical methods. This change requires both a revision in our texts and in our teaching methods.

During the past ten years, a number of new and revised texts have been presented to meet this need. Most of these have been either hydraulics texts, modified to include such studies as dimensional analysis and dynamic similarity, or so advanced in the study of fluid mechanics as to be outside the scope of undergraduate work.

Professor Binder's book on fluid mechanics strikes a happy mean between these two extremes. His book presents an introduction to the fundamentals of fluid mechanics which can be grasped by students in their junior year. His presentation is brief and to the point. The general plan of presentation follows somewhat that used in presenting rigid body mechanics, dealing first with statics and then with dynamics.

The ground work for fluid mechanics is presented in the first six chapters which cover statics, kinematics of fluid flow, the energy equation, viscosity, and dimensional analyses. The general energy equation is used rather than the special form represented by Bernoulli's equation. Dimensional analysis is well presented in the six pages allotted to it.

The remainder of the book is devoted to flow of incompressible fluids in pipes and channels, flow around bodies, flow of compressible fluids, dynamic lift, and propulsion. Special consideration is given to lubrication, pumps, turbines, fluid couplings, and torque converters in several of the final chapters.

Throughout the book, discussions are brief. Step-by-step development of equations and formulas is avoided. The hydraulic tables and diagrams generally found in hydraulics texts are omitted in favor of more broadly applicable relations. This is in keeping with the author's aim of presenting only the fundamentals of fluid mechanics. While the discussions are brief, they are well supplemented by the "selected references" listed at the end of each chapter. Numerous problems give the student ample opportunity to test his mastery of the subject matter.

This book is a welcome addition to the supply of texts for undergraduate work. It is truly an elementary text on fluid mechanics.

Marvin Bogema
Assistant Professor of Hydraulics

Handbook on Designing for Quantity Production, by Herbert Chase, McGraw Hill Book Company, 1944, 517 pp., $5.00

This book should be in the hands of every person who is or soon will be engaged in post-war product development. It is recommended to executives for its inspiring viewpoint and to the designer for the clear presentation of the facts that are of interest to him. The form of the book makes it well suited as a home study text for the young designer after graduation.

The book is in two parts, with eight chapters in the first and seven in the second. Mr. Chase has chosen a capable group of authors to assist him with part one of the book. The second part of the book is handled entirely by Mr. Chase and is devoted to a comparison of the various methods of production described in part one.

Mr. Chase, being a well qualified writer on the subject of die castings, opens the book by completely selling the reader on the use of zinc die castings. This is accomplished not only by his enthusiasm for the subject, but also by his presentation of much factual data for the designer.

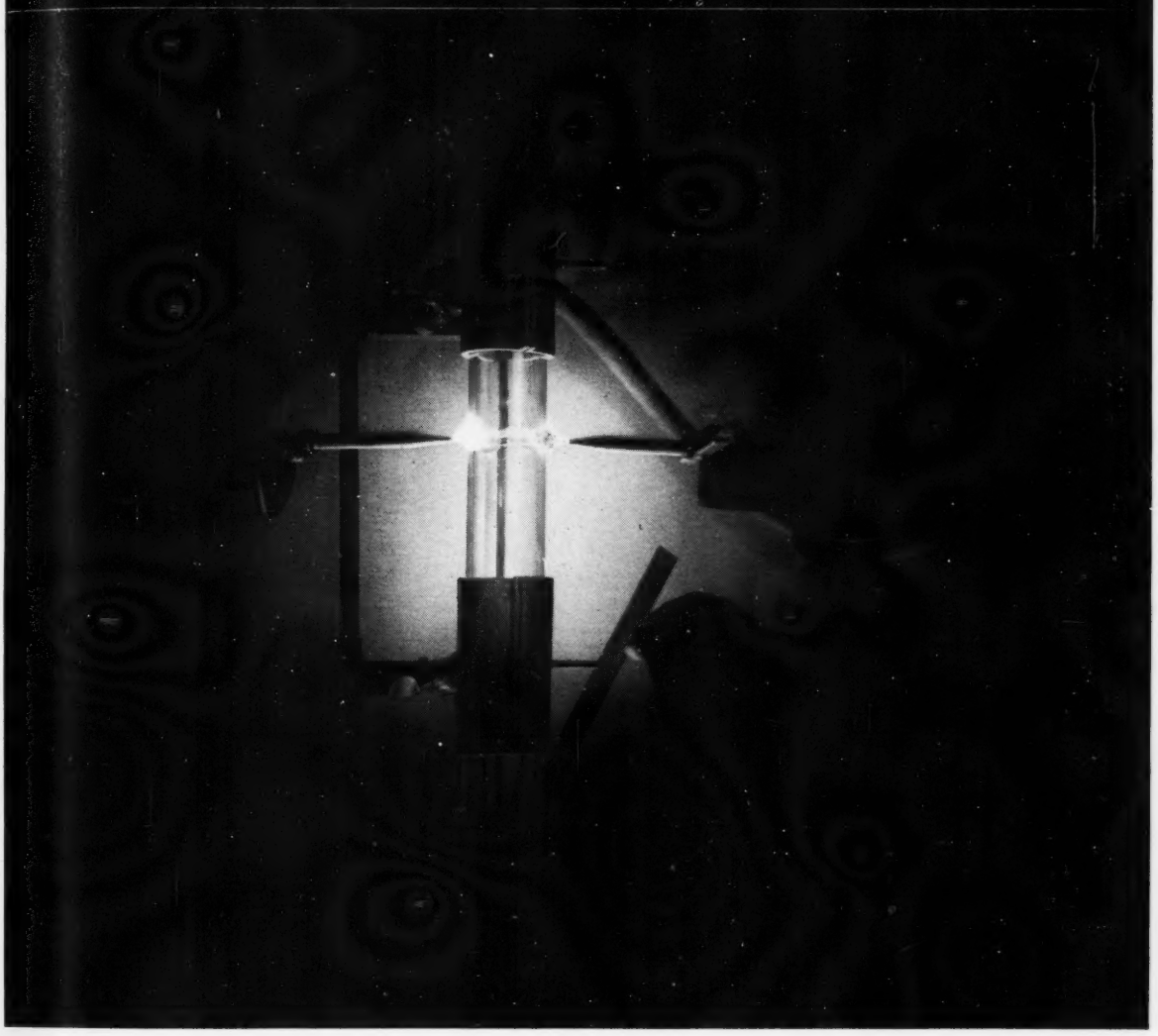
Chapter II is written by Mr. N. F. Hindle of the American Foundrymen's Association on the design of sand castings. This chapter includes useful data on the physical properties of sand cast materials. These data would have been more complete, however, had they included some information on the machinability of the various sand cast materials.

Chapter IV is written by Mr. Ralph A. Wagner of Consolidated Aircraft Corporation on the design of stampings. The material presented is very complete. Thirty-six rules for design bring together information on the design of stampings that sums up a great deal of practical experience. Of particular interest to the designer will be the large number of illustrations showing the use of ribs to stiffen sheet metal parts.

Chapters V, VI, VII written by Messrs. Charles Tutt, Jr., A.E.R. Peterka, and Mr. Chase, cover the subjects of hot and cold forging. Much of the good design material in these chapters has heretofore been spread out in many different books, technical publications, and commercial literature, and the de-

(Continued on page 38)

Sewing glass with a thread of fire...



FOR a long time industry has wanted a method by which two or a thousand pieces of glass pipe could be joined into a continuous piece. Corning has worked out a high-frequency electrical welding process that literally sews glass with fire.

It has these advantages: 1) It's faster than old methods. 2) It makes a smooth, transparent joint, just as strong as the pipe itself. 3) With the new portable welding equipment it may soon be possible to go into a food or chemical plant and install continuous glass piping right on the job.

Welded glass pipe isn't available now except to certain war plants. But it's another interesting development that points to a greater use of glass when some of the present restrictions on production are behind us. Others are a new type of glass so resistant to thermal shock that it can be heated cherry red and then sprayed with ice water without breaking; "ribbon glass" in sheets almost as thin as cellophane; and a new method by which accurate shapes of almost any size or description never before possible in glass can be quickly formed. Glass is going to play a major role in post-war. And Corning will be there with what it has learned during the war plus a background of nearly a century of glassmaking experience. You can count on it. Glass, the material with a sparkling future, will keep full pace with your own sparkling future as an engineer. Corning Glass Works, Corning, N. Y.

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Research in Glass

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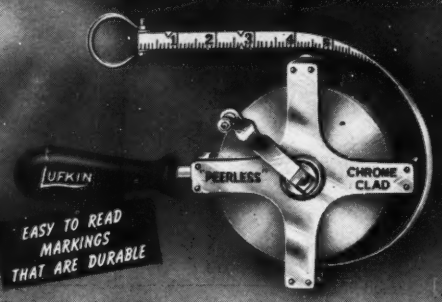

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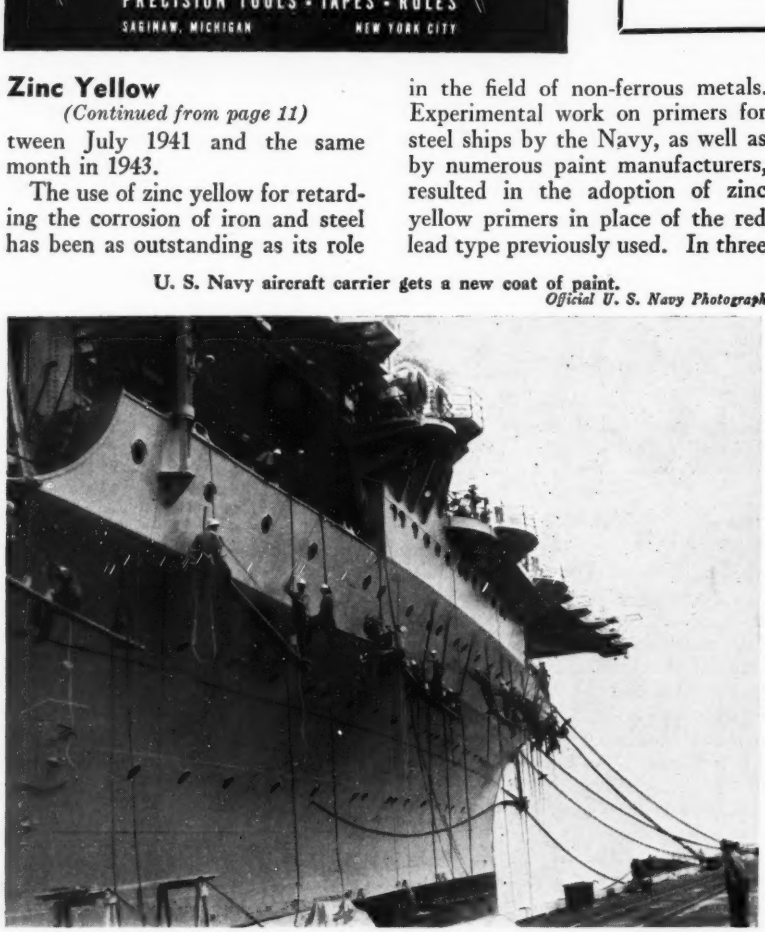
Zinc Yellow

(Continued from page 11)

tween July 1941 and the same month in 1943.

The use of zinc yellow for retarding the corrosion of iron and steel has been as outstanding as its role in the field of non-ferrous metals. Experimental work on primers for steel ships by the Navy, as well as by numerous paint manufacturers, resulted in the adoption of zinc yellow primers in place of the red lead type previously used. In three years approximately 2,200,000 displacement tons of ships were built for the Navy, including fighting craft, mine layers, landing boats and auxiliary craft. Zinc yellow primer was used on all of this naval equipment for rust inhibition. It has been estimated that zinc yellow is now being used on Navy ships to the extent of approximately 6 million pounds per year. This was consumed as approximately 2 million gallons of primer, which is enough to cover close to a billion square feet of surface. The United States Maritime Commission, which has built 50 million deadweight tons of ships, has specified the use of zinc yellow primer.

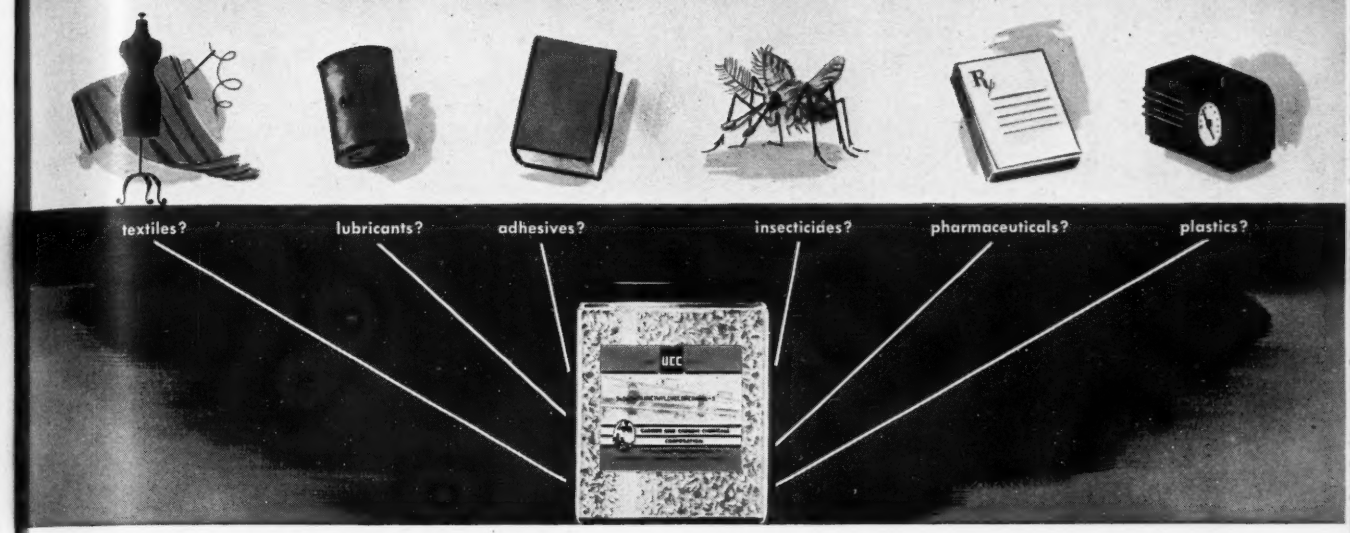
U. S. Navy aircraft carrier gets a new coat of paint.
Official U. S. Navy Photograph



The Army makes use of zinc yellow in metal primers to protect jeeps, trucks and tanks. The chief inhibitive pigment used by the Engineer Corps in the paint coating on camouflage steel wool is zinc yellow.

These uses indicate that zinc yellow pigment is going nearly one hundred per cent into war paint as a metal primer. Whether that metal be steel, aluminum or magnesium, zinc yellow is retarding effectively the ravages of corrosion.

What would you do with some 3,3,5-trimethylcyclohexanol-1?



EVEN *we* know only a little of what you might do with it... yet. Trimethylcyclohexanol (you pronounce it try'-meth'-il-sy'-klo-hex'-an-ohl) is a new industrial chemical by CARBIDE AND CARBON CHEMICALS CORPORATION... made with atoms obtained from common substances, rearranged into molecules that are not known to exist in nature.

What's this new synthetic organic chemical good for? No one yet knows all of the useful things it might be made to do. If you are technically minded you'll find some of the facts so far discovered in the italicized paragraph at the right. Whatever your interest, you will be glad to know that this new chemical has potential uses in the making of such things as medicines, plastics, lubricating oils, and adhesives.

In their service to industry as incubators for raw materials, the laboratories of this Unit of UCC are continually developing such new chemicals. An almost predictable percentage of them prove to be extremely valuable. Out of hundreds already developed have come scores from which scientists in industry have developed useful products of many kinds.

Some of the chemicals are used to make superior anti-freezes. Others are raw materials for quantity production of vitamins and life-saving drugs. Still others make possible improved cosmetics, plastics, textiles, photofilm, insect repellents, anesthetics... and hundreds of things of benefit to you in your daily life.

Through continuing research which is developing new materials out of common substances, CARBIDE AND CARBON CHEMICALS CORPORATION is helping to make many things more plentiful or more useful. And the research of this one Unit... in that field which often must appear to the layman as "unknown chemicals"... gives you an idea of what the combined research of all UCC Units in many basic fields means to you.

▼

Model of Molecule of Trimethylcyclohexanol

As Trimethylcyclohexanol is one of the newest additions to this family of synthetic organic chemicals, its story is still incomplete. It is an alcohol with a high boiling point (388° Fahrenheit). At room temperature, it is a white solid with an odor like menthol. It dissolves in other alcohols, gasoline, benzene, ethers, and vegetable oils like linseed oil, but does not dissolve in water. It can be supplied in carload quantities if and when the need arises.

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The Oxweld Railroad Service Company
The Prest-O-Lite Company, Inc.

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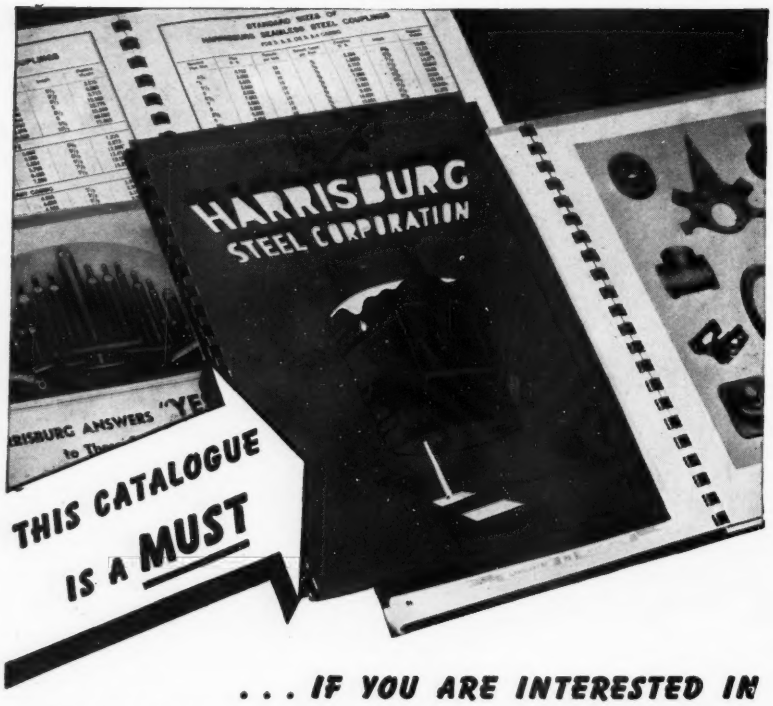

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Tin Fish

(Continued from page 13)

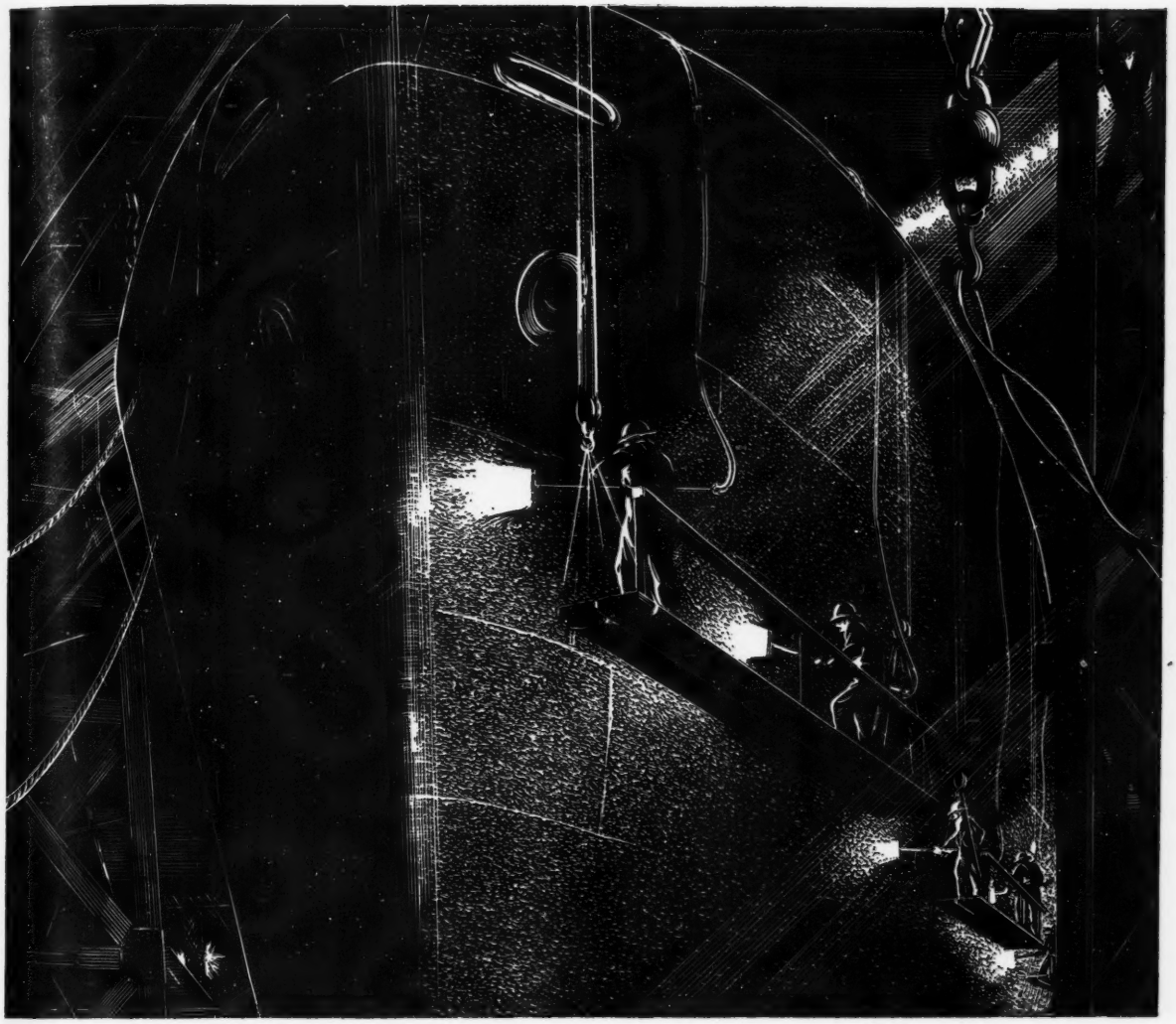
est German torpedo has a maximum range of only 2,000 yards and a usuable range of about one-half a mile. This is because the compressed air storage space has been reduced to allow more room for explosives. Some of the newer German torpedoes also have sharp blades protruding from their sides to enable the torpedo to cut its way through wire nets in harbor entrances.

Wake Control

The older torpedoes used to leave a wide, white wake. Cold, compressed air from the exhaust would produce this effect, and the torpedo could easily be detected from a distance. The modern type, however, leaves almost no wake. The exhaust gases now consist principally of a mixture of hot air and steam emitting from the tail of the torpedo. Upon striking the cold water the steam condenses, and small bubbles of hot air rise to the surface. These bubbles are very hard to detect even at a distance of one hundred yards.

Even though the modern torpedo's mechanical operation is practically perfect, a fairly large number of them miss because of incorrect calculation of the factors involved or evasive measures taken by the target. The course of today's "tin fish" is determined before it is sent on its mission, but for a long time experts and inventors have been concentrating on the perfection of devices to keep the torpedo headed for the target under all circumstances. Many experiments have been conducted on the practicability of many types of controlled torpedoes; so far, however, only one type has reached any degree of perfection. In the last few months Germany has perfected and put into use a magnetic torpedo. At present this torpedo is used only to make the regular type more effective by damaging a ship's propellors and rendering it unable to take evasive action against the "free" torpedo. The magnetic torpedo is smaller than the usual type; it is guided to its target by the same method as the magnetic mine of the last war. This torpedo is projected through the U-boat's nose towards the stern of a ship and is

(Continued on page 28)



Scrubbing Steel Ships with Brushes of Flame

Painting a big modern cargo or troop ship is an expensive and important finishing operation. To assure the longest possible paint life, many large ships are first thoroughly cleaned with "brushes" of oxyacetylene flame — a steel-conditioning treatment that produces a clean, smooth surface unblemished by rust or scale.

Moreover, this modern steel-cleansing method drives occluded moisture from the steel, thus making it more receptive to paint and making paint jobs last longer. As a result, repainting becomes a much less frequent necessity...maintenance costs are considerably reduced.

In addition to cleaning steel, the oxyacetylene flame has many other uses. It cuts metals into any shape quickly...surface hardens them at points of wear... welds them into strong parts. With the electric arc, it constitutes a remarkably fast, versatile metal-fabricating team.

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Future possibilities depend entrely on the success of the organization as a whole. These are not positions for high pressure salesmen but for hard-working engineers who can sell by service and information, which they can give the customer to solve his problem.

Applications must be under War Manpower Regulations.

PERRIN-PAUS COMPANY
8 So. Michigan Avenue
Chicago 3, Illinois

Tin Fish

(Continued from page 26)

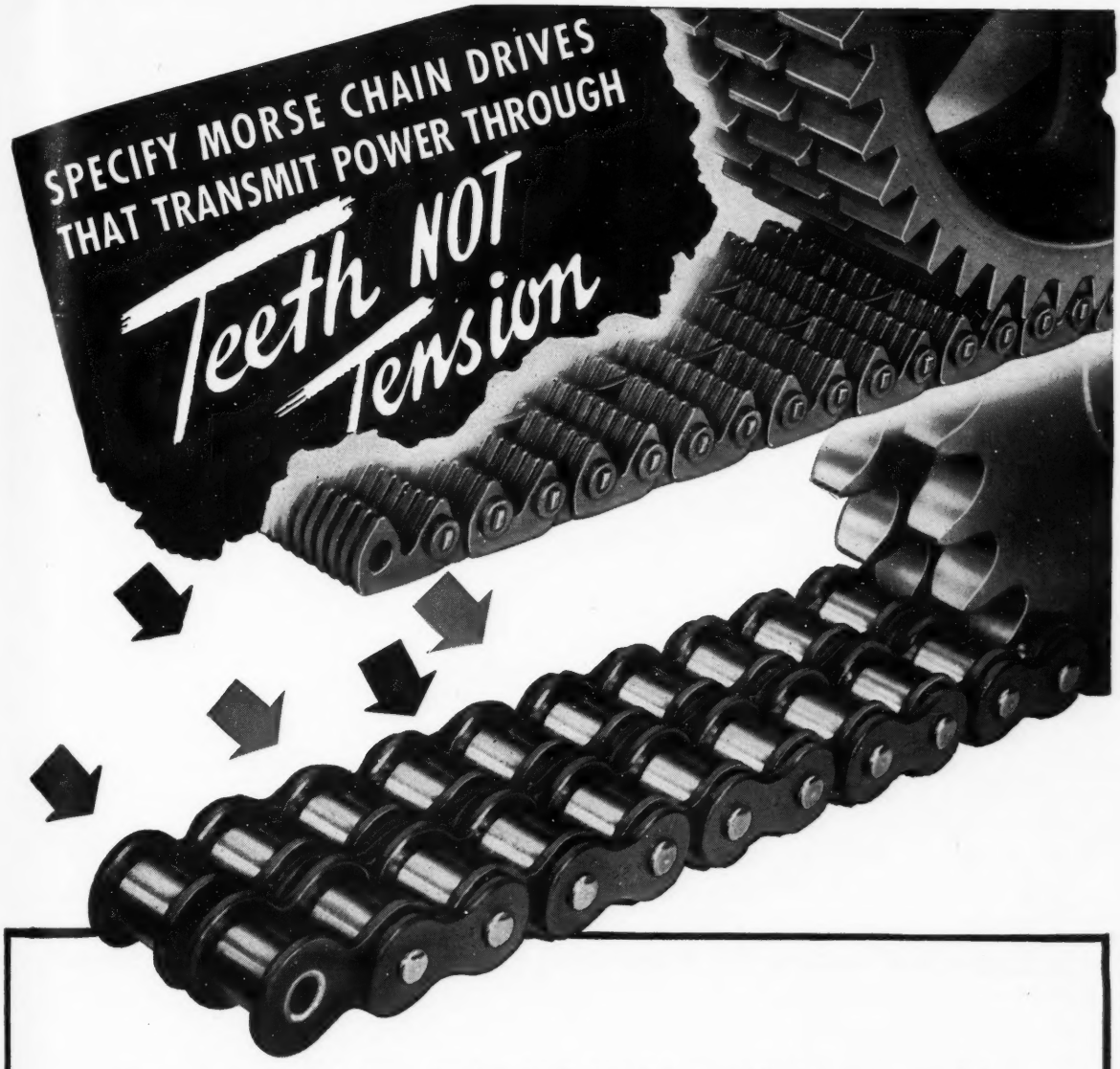
attracted to the ship's steel hull by a strong electro-magnet. There the vibrations of the ship's propellers set off an explosive charge, and the vessel is thus disabled and vulnerable to further attack. The United Nations have not yet been successful in capturing one of these torpedos, and no information is available concerning their structure and operation. However, the power to run this projectile is probably generated by an electric current operating a small, powerful motor.

Wireless, Sound and Light Control

Experiments have also been conducted with torpedoes in which the torpedo is controlled by wireless, sound, and even light. Very little is known about these methods except their general scheme of operation. The naval authorities of all powers are working in great secrecy, but much progress is known to have been made in the practical development of the controlled torpedo. During the first world war a torpedo controlled entirely by wireless was demonstrated but proved to be too clumsy, inaccurate, and easily detected. The great difficulty in the wireless torpedo is that the Hertzian waves, on which electrical impulses are transmitted to the receiver, only occur appreciably in the atmosphere. To pick up wireless signals the torpedo would have to be fairly close to the surface with some sort of antenna above the water. It could then be easily detected from a distance and would probably strike a ship at her most heavily armored point. It must be obvious now that the wireless torpedo cannot compete with the modern type, and it will probably never be in use. However, recently much progress has been made in the development of torpedoes controlled by sound or light. These processes are in their infantile stages, though, and much more research has to be done to perfect them. Practically no information whatsoever has been let out concerning the operation of a torpedo steered by light. These torpedoes are known to operate like the regular type except the steering is controlled by selenium or photo-electric cells. The light to control these cells probably comes from the torpedo tubes of the submarine, but is simply a scientific guess. However, a great deal more is known about the operation of torpedoes controlled by sound. In the sound steered torpedoes the vibrations of a ship's propellors are made to operate an electric circuit and steer the torpedo towards the vessel. This is accomplished by a microphone which picks up the sound vibrations and transfers them into electrical impulses; the microphone works exactly like the mouthpiece of a telephone. The electrical impulses are used directly to operate the vertical rudders. Electric motors must be used in the torpedo, so that the propellor vibrations can be easily detected.

"Free" Torpedo Best

Although the controlled torpedo is coming more to the fore, it is still surpassed greatly by the modern "free" torpedo. It will undoubtedly take a much greater amount of time and research before the torpedo of today, the weapon that has changed the entire aspect of naval warfare, has found its equal in any other type of underwater projectile.



POWER transmitted along slipping, inefficient drives rapidly becomes wasteful —causes undue expense and decreases machine capacity.

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Power-Recovery System

(Continued from page 8)

or water energy-dissipating system.

Aircraft Engine Testing with Propellers

The aircraft-engine industry has made testing developments of its own so that a variety of testing schemes are available from which the designer of an engine-testing procedure and layout may choose. But in the manufacture of the large engines produced today, the selection of a testing scheme would probably resolve into a choice between testing with propellers similar to aircraft propellers and testing with power-recovery.

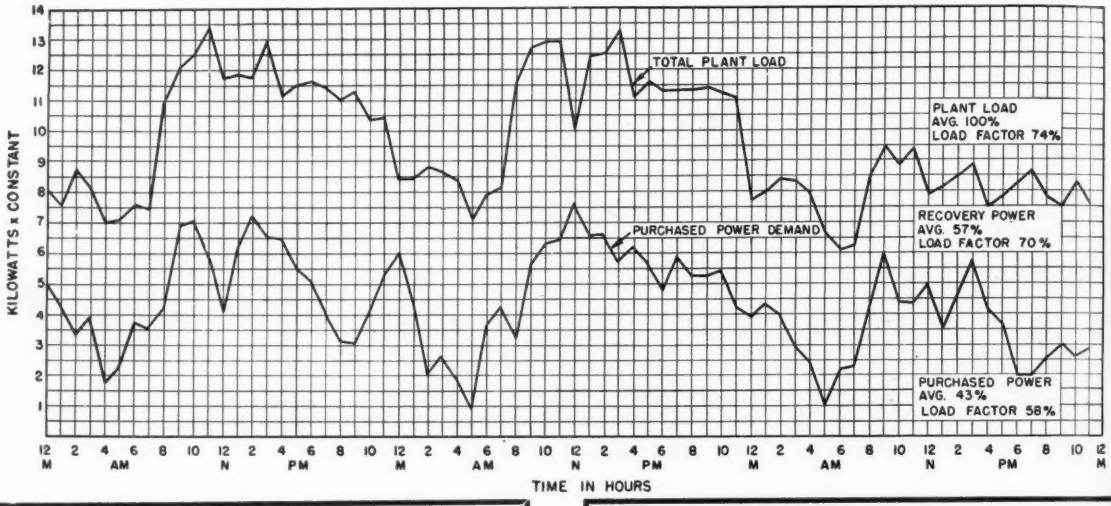
Two typical physical arrangements for these schemes of testing are shown in Figures 2 and 4. It will be noted that the structures shown differ fundamentally: with propeller testing, the structure must be designed to accommodate the air stream set up by the engine loading propeller; whereas with the power-recovery system, this is not necessary because the air stream is not present.

Recovery of Power

Knowing the engine sizes and rates of production, and the horsepower-speed-torque characteristics

(Continued on page 31)

Fig. 5.—This 72-hr. total plant power chart shows plant load, power recovered from the test stands, and purchased power. The area between the two curves represents the power supplied to the plant by power-recovery test stands. In this records, 57 per cent of the total plant load is obtained by power-recovery and 43 per cent is purchased from the connected power company.



Good Quality Makes Good

There's no record that gives any clue to the construction of Little David's slingshot. Give Davey all the credit for his bravery . . . but some credit is due to the sling shot. It had the stuff. Davey probably whittled his biblical Garand out of well-weathered cypress, and tanned by hand the leather thongs that completed his lethal weapon. It had quality!

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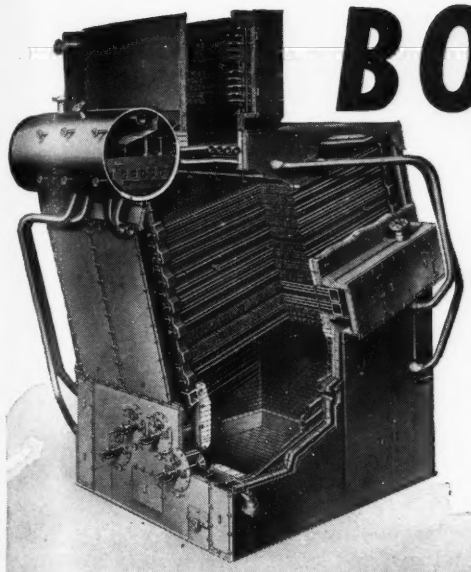

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Power-Recovery System

(Continued from page 30)

of the testing cycles, it is a simple matter to calculate the expected recovery of energy. These calculations will predict minimum (pessimistic) results expected, however, because they will not take into account tests that have to be repeated for one reason or another, tests called penalty runs. For the purpose here, therefore, it is preferable to use actual test data and records.

From the standpoint of individual engines, records show that from each of the present engines of large rating coming off an assembly line there may be recovered anywhere from 3000 to 6000 kw-hr of energy.

From the standpoint of over-all engine manufacturing plant operation, Fig. 5 is indicative of what may be expected. This figure is the plotting of the over-all performance of one of the new engine plants for a period of 72 consecutive hours. The plotting is actual normal plant performance made from instrument readings taken at the plant for the period indicated. The top curve shows the plant power consumption. The bottom curve shows the power purchased from the connected public utility. The difference between the two is the power recovered from the power-recovery test stands. It will be noted that this recovered power is more than half that required to operate the plant.

A similar over-all plant performance for a period of six months again showed power recovery exceeding half of the total power required to operate the plant during that period. Month by month the percentage of total plant power consumption furnished by power recovery was:

Month 1: 54.6	Month 2: 53.7
Month 3: 53.0	Month 4: 53.7
Month 5: 59.6	Month 6: 57.3

Referring to Fig. 5 it will be seen that power-recovery testing also reduces power demand and consequently purchased power-demand charges. Without power-recovery testing, demand charges would be based on the top instead of the bottom curve. Obviously, also, the capacity of interconnecting apparatus such as transmission lines and transformers would have to be based on the top instead of the bottom curve.

The power-recovery system saves energy, reduces demand charges and reduces interconnecting apparatus capacity, and does all this to an important degree. A propeller test stand will not do any of these things. These are important accomplishments that are of direct interest to the engine builder.

Measurement of Engine Loading

Besides the advantages enumerated at the outset of this article, the power-recovery system of testing carries the important advantage that it is still open to expansion and improvement. This system of testing is very new; its full possibilities have not yet had time to develop.

One such possibility is the accurate measurement of engine loading by electric-instrument measuring techniques. Having converted the mechanical energy output of the engine into electrical energy the basis for such measurement is present. This is an important asset of the power-recovery system of testing that is open to the engine

(Continued on page 32)

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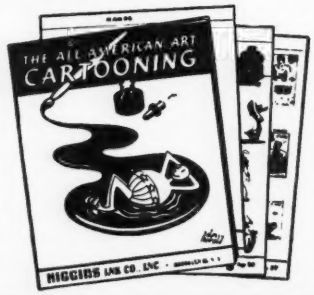

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Power-Recovery System

(Continued from page 31)

builder. It is an involved subject, however, and entails departure from aircraft engine testing procedure of long standing.

Cost of Power-recovery Testing Equipment

When all pertinent considerations are taken into account, the cost picture surrounding power-recovery testing is particularly favorable. From a cost standpoint, the question is: How much more does a power-recovery system cost than a system in which power is not recovered, for example, the propeller system? In other words, to justify any greater cost for power-recovery testing it is only necessary to justify the difference between the cost of power-recovery testing and such another system as may be contemplated.

The cost of the test-stand equipment required for a large engine power-recovery stand will likely be between $20,000 and $30,000. This equipment cost is largely offset, however, by the simpler building structure permissible with the power-recovery system. Those that are in a position to know building cost differences and such other cost differences that enter into over-all cost computations have submitted cost differences ranging from nothing to $15,000 per test stand for a power-recovery testing system of the capacity being discussed in this article.

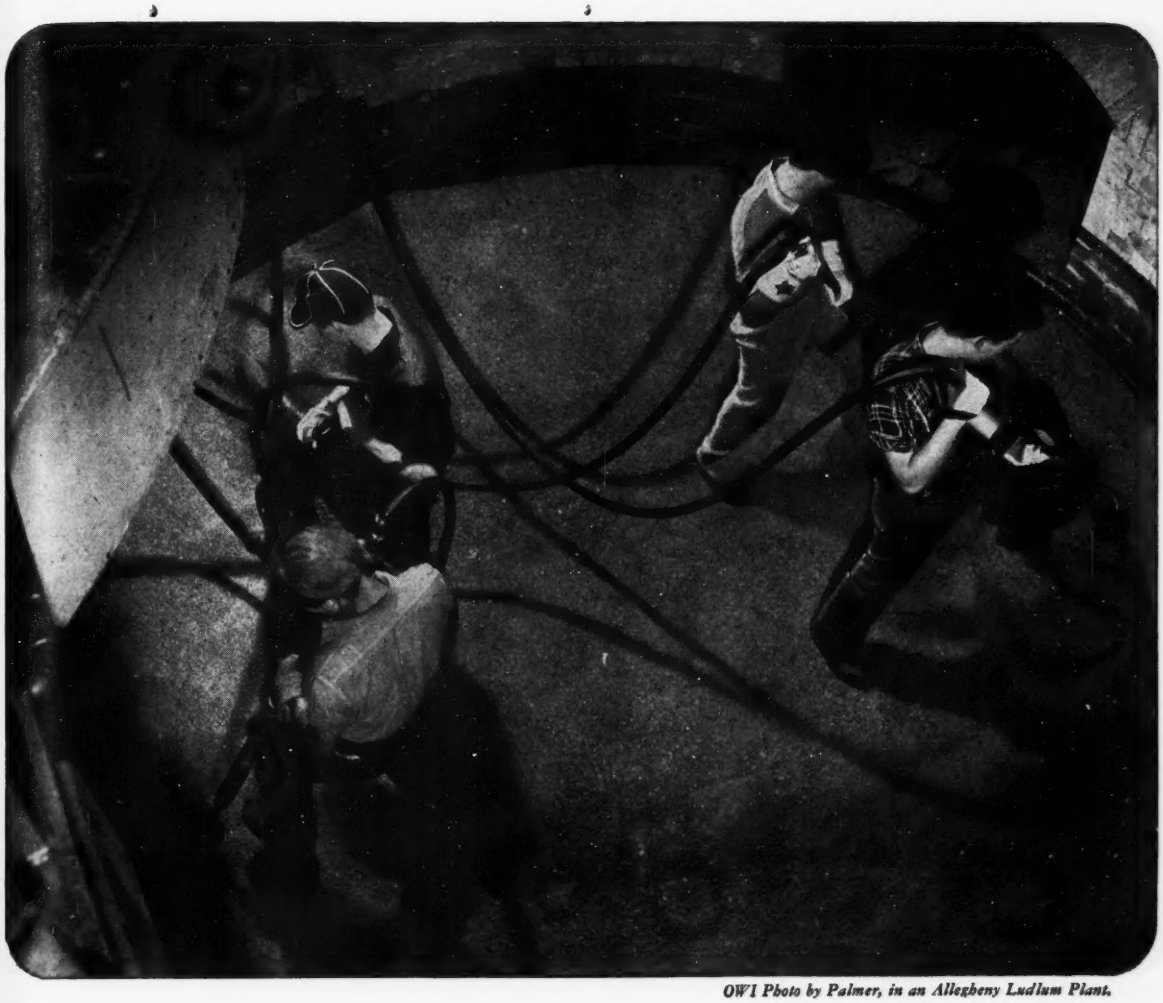
Assume that the difference standing against power-recovery testing is $15,000. Assume likewise that 1.5 engines per day per stand per 300-day year are tested at a saving in kw-hr per engine of 4000. Then with power at $0.004 per kw-hr the annual saving is $7200. The corresponding amortization rate is slightly over two years. In other words, the cost difference is eliminated in slightly over two years and thereafter the savings continue indefinitely. A non-recovery testing system cannot present such an outlook from an investment standpoint.

Furthermore, this cost picture is not the best that can be presented It does not take into account reduction in power-demand charges. Likewise it does not take into account the possibility of testing engines more quickly by power-recovery and consequently the possibility of installing fewer stands for a given plant engine output.

Future of Power-recovery Testing

The advantages of the power-recovery system as applied to the testing of aircraft engines have not yet had time to be universally appreciated. The statements made in the preceding paragraphs are simple engineering facts, easily checked, and they all point to the conclusion that power-recovery testing has intrinsic value that cannot be passed by lightly. Power-recovery testing has advantages that cannot be secured from any other form of testing.

But in the final analysis, it is the engine builder and not the electrical engineer that will point the way and decide to what further extent power-recovery testing will be used. It may be quite possible that with the passing of time the engine builder will point with more and more favor because he is already pointing toward larger aircraft engines—and the larger the engine the more advantageous power-recovery testing becomes.



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Bill Rothfuss

(Continued from page 15)

of alcohol since—without moderation. On another occasion, the explosives he was cooking up detonated accidentally. Finding his own clothes burning, as well as those of the friend with whom he was working, and discovering also that the house was burning were considerable jolts to the youthful chemist. In the desperate activity which followed, all fires were extinguished, but by that time the cellar floor was several inches deep in water. As a secondary hobby, Bill built a complete photography darkroom in the basement, which also became the scene of another sidelight interest—radio.

Bill won recognition in high school football, track, and marksmanship, participating also in dramatics and in state-wide mathematical competitions of the brain-smashing calibre. Upon graduation from high school as president of the senior class, Bill received a cup from Dartmouth College for an exceptional four years' record in scholarship and extracurricular activities.

In September, 1941, Bill entered the Cornell School of Chemical Engineering with a McMullen Engineering Scholarship. In the same year, he became a member of Psi Upsilon fraternity, later to be elected its secretary. Toward the end of that year, Bill ran the Freshmen Banquet for fraternity men and independents alike. Bill used every expedient to guarantee the banquet's success — everything from distributing free cigarettes at the door of Willard Straight Hall, as a publicity stunt, to trouping around wearing little more than a barrel, bearing the inscription: "I Hocked My Clothes To Go To The Frosh Banquet." Largely through his perseverance, including the barrel incident, the Freshmen Banquet was among the most outstanding in years.

Several months later, Bill was elected to represent the sophomore class on the Student Council for the following term. As co-chairman of a Council committee, Bill aided in the sale of over twenty thousand dollars in war bonds and stamps. A later appointment placed him on the Faculty Committee on Student Conduct. Last term, Bill, assisted by Jan Savitt, made an overwhelming success of the New Year's Dance.

Working his way up through the jayvees, Bill won his major "C" last spring in the varsity crew regatta on Severn River at Annapolis. That, you will recall, was the race in which the Cornell crew nosed out the highly-touted Navy oarsmen. This past winter, Bill was "number seventy-two man" on the varsity football squad. Now Bill is out for track, an old high school pastime. Carrying his sailboat racing into college, Bill has made several trips to Eastern colleges for the regattas of the Intercollegiate Yacht Racing Association, which recently elected him to its executive committee. For the past two years, Bill has been commodore of the Cornell Corinthian Yacht Club. Through his initiative, the club is making definite plans for the erection of a new and permanent boat house. Elected to the Crew Club, he is secretary this year.

Today, as president of the Student Council, Bill occupies the most

(Continued on page 36)

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Bill Rothfuss

(Continued from page 34)

responsible position in Cornell student government. Under his leadership, the Council has done more than perhaps ever before to unite students in a genuinely representative and democratic self-government. Moreover, Bill, who made the Dean's List every year, was recently elected to Tau Beta Pi, honorary engineering society, and Al Djebar, honorary society in chemistry.

As a member of the V-12 Navy program, Bill now completes his final term in Chemical Engineering. The immediate future will demand additional months at the Cornell Midshipmen's School. But—what next year will bring is difficult to predict. Nevertheless, Bill has expectations of working on P.T. boats or possibly on submarines. Perhaps it will just be second command on L. S. T. (nautical lingo for Large Standing Target). Bill looks forward to using his college training for later work in petroleum engineering. It must be said, however, that he is entertaining the idea of setting up, as a sideline, a boat building factory on Lake Cayuga, with the possible aid of his brother, Richard, an aspiring naval engineer.

This is certain. Whatever he may do, wherever he may go, Bill Rothfuss will provide superb human material. Serving others, he will serve the future.

Dick Hillman

(Continued from page 14)

and he sings in the Presbyterian Choir and the Chem E. Quartet. (The Quartet now numbers twenty-four.) Dick is a brother in the Sigma Nu Fraternity and has served as vice-president of his chapter. He was a member of the Inter-Fraternity Council while that body was still in existence. Among his other pastimes Dick once included bridge-playing, but he hasn't found much time for that recently. The fact that he has been elected to two honorary societies, Al Djebar and the Retort and Beaker, shows that, with all these activities, Dick has found ample time for study.

Dick is of medium stature and has wavy blond hair, one lock of which often hangs jauntily over his forehead. He speaks, with a soft, well modulated voice and has a sharp sense of humor which is betrayed by his twinkling, reflective brown eyes.

Upon his graduation in June, Dick hopes to receive a commission from the Navy. Although he has taken most of his electives in metallography, he has no desire to limit his field at present, but would rather do general development work in the chemical industry.

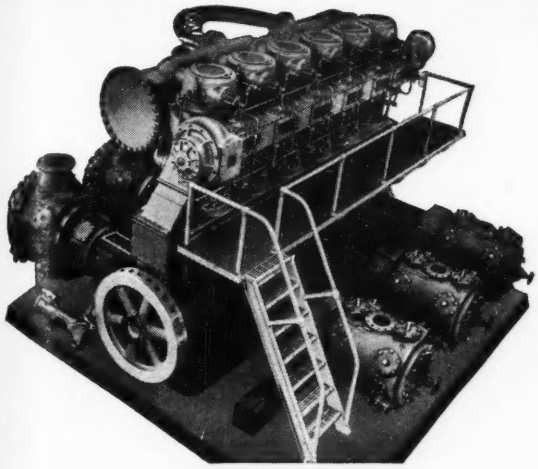
Dick's "one and only" is a Cornell co-ed. Asked whether he had made any post-war plans, Dick colored slightly, grinned, and replied, "Yes, I have. After the war I'd like a good job, some money in the bank, an automobile or airplane, a boy, and then twin girls."

Bob Garmezy

(Continued from page 15)

the summer of 1943, he paused in his teaching and learning long enough to don the traditional cap and gown and receive the BEE degree with distinction. Then, at the age of 19, he was appointed a full time instructor in Electrical Engin-

(Continued on page 38)



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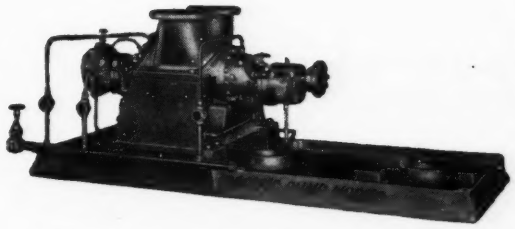

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Bob Garmezy

(Continued from page 36)

eering at Rand Hall.

Feeling that a broad understanding of the engineering field will be valuable, Bob is continuing his studies in the ME School. The postwar question mark seems to point toward the Orient for Bob. Life in the Philippines and travels even farther West have given him a first hand look at the problems and possibilities of relatively undeveloped lands. At any rate, all that know him will say that he is destined to be a success wherever he goes. His hearty enthusiasm for life in general will give him strong moral support. When he leaves Cornell, he will go out armed with an outstanding engineering background to leap technical hurdles and, possibly more important, a winning smile and sincere handshake to make friends with all he meets.

Publications

(Continued from page 22)

signer will be pleased to find it all brought together into one book. These chapters do not deal in generalities, but come right to the point. The authors tell the reader exactly what commercial tolerances can be maintained economically. The machining time saved by the use of forgings is well illustrated by photographs showing the pile of chips removed from a forged part compared with the chips obtained when the screw is milled from the bar.

The last seven chapters provide a comparison of the various manufacturing processes. The author considers the processes in regard to weight, section thickness, coring, smoothness, dimensional accuracy, tooling and material costs, machining and finishing costs, strength, hardness, and appearance. The author is very enthusiastic on the subject of die castings and too often leaves the misleading impression that this process is without rival. The rigid purity control necessary with zinc when used in dit castings places many limitations on their use, however. This factor is somewhat avoided by Mr. Chase.

The book is a splendid reference book, although not too well suited as a college text. An industry interested in post-war planning could profit by making the book available now to their designers.

Walter A. Johnson
Assistant Professor of Machine Design

"Loose Juice"

(Continued from page 20)

important enough to warrant his attention, Hugo registered in Mechanics Computation 220B, and, according to the latest announcement from the CE Honor Committee, he has kept up with his problems.

Evidently Bjork thinks that organic chemistry is a most important part of a man's career, since he is registered in that course, which is not ordinarily given CE's. As Chem I and II are prerequisite, he also booked these courses. This, however, is just not done, according to Mr. Conklin of that department, who phoned Hugo and asked him which course he would prefer to take. Bjork's answer, unfortunately, was not made public.

Rounding out his courses in Lincoln Hall, Hugo has brought to Descriptive Geometry 204 an artistic temperament, as well as an engin-

(Continued on page 40)

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1. At one of the critical engagements of the North African campaign the American officer in command of a vital sector developed a wow of a toothache. Now he certainly would have won that victory, toothache or no toothache. But he didn't have to go into battle distracted by that pain-thumping molar because there was a dental unit right at hand to take care of him. Whether they are working close to the battle front or on your pet incisor here at home, dentists generally use tiny abrasive points such as are made by Carborundum.

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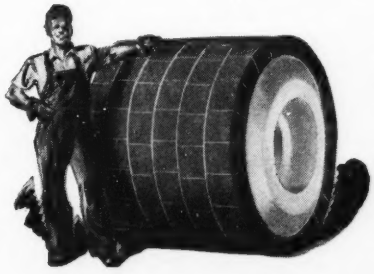

3 The complete abrasive and refractory service that Carborundum offers industry will be of help to you in your work in the field. When you are in industry feel free to call on us for assistance. The Carborundum Company, Niagara Falls, New York.

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"Loose Juice"

(Continued from page 38)

eering mind. The plate illustrated above is but one of the many he handed in to the great delight of his instructor, Mr. Saad.

Hugo did not ignore his extra-curricular activities. He was heard over CRG (at first it was thought a gremlin had invaded the studio, but the first is a more plausible explanation for occasional CRG static) and is scheduled to appear soon at Straight SRC music recital. Though he appeared at the CE party Friday, April 21, he did not stay long enough to be interviewed. He was last seen going over the hill with five cats.

This matter has of late gotten out of hand. After 2 months Bjork continues to haunt and elude the CE soph class. This has had a disastrous effect on their morale. In order to avoid greater mental disintegration among his classmates, John Gnaedinger, president of the class, has announced a reward for the apprehension and identification of Hugo R. Bjork. This reward will consist of a pair of tickets to the next Straight Open House, either Saturday night or Sunday afternoon according to the preferences of the recipient.

For the sake of the CE class of '47, the CE School, the College of Engineering, and a certain coed in Balch IV, the CORNELL ENGINEER joins the world in the hunt to determine: Who is Hugo Bjork?

Telegraph and Cornell

(Continued from page 9)

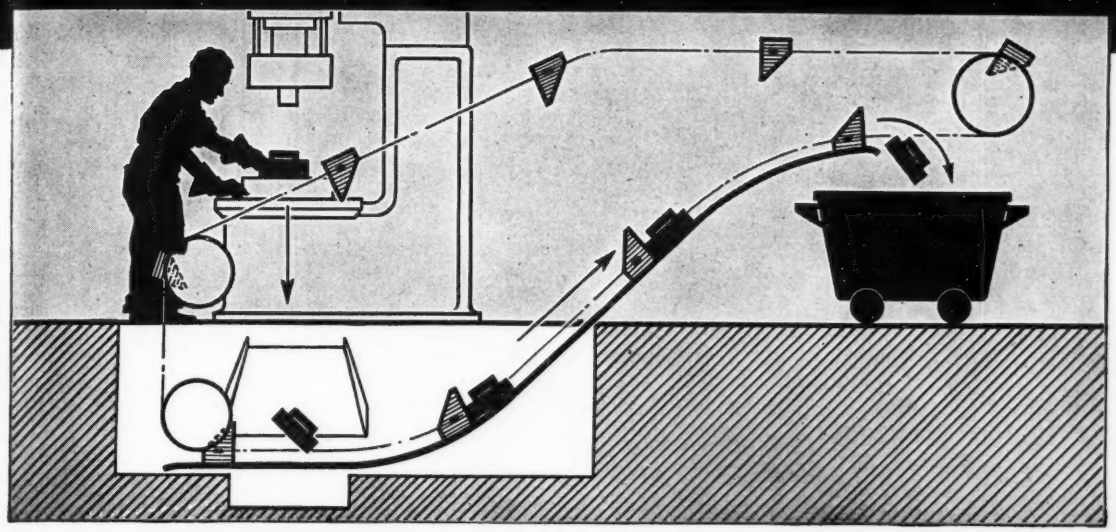
brating the centennial of the telegraph's invention will be issued; in Baltimore, a Liberty Ship, "The Samuel Finley Breeze Morse" will move down the ways; and in the Hotel Statler in Washington, the world will remember Morse and his telegraph. On that day radio broadcasts will redramatize the original scene. The "Double or Nothing" program on May 19, at 9:30 P. M. will use the Centennial Anniversary as its theme. The following day, the "Blue Playhouse" will offer a re-enactment of the story over its stations between 12:00-12:15 P. M., and "Life" magazine will offer coverage in one of its forthcoming issues.

The message will retravel its original route, from the Old Supreme Court Room in Washington to the Baltimore and Ohio Station in Baltimore, and then back again. Receiving the message will be the same receiver used 100 years ago. This receiver is being borrowed from Cornell University for this occasion. It was presented to Cornell by Hiram W. Sibley, son of Hiram Sibley, second president of Western Union. The statue of the University's Founder has mounted in the rear a replica of this original instrument. The statue itself was erected by the Board of Trustees on the occasion of the University's Semi-Centennial Anniversary celebration. Interesting is the fact that the early Morse receivers actually recorded messages in dots and dashes on the paper tape.

An interesting sidelight of the entire affair is the fact that the founding of the telegraph is indirectly responsible for the foundation of Cornell University. Because of the fortune that he was able to amass in the telegraph industry, Ezra Cornell was able to found and give his name to the University.

So as the world pays homage to Morse and the telegraph on May 24, they might do well to cast a glance on the footnote in history to Ezra Cornell.

How LAMSON Found 24 Additional Workers . . . *without increasing the payroll!*



★ A large Detroit forge plant required two men, besides the operator, on each of 12 hammers, to lift forgings from a pit where they were dropped by the machines, to floor level and into trailer trucks.

Lamson engineers devised the 21-foot pusher flight conveyor illustrated. As an immediate result of this Lamson installation, 24 men were released for more productive work. The confusion, delays and accident hazards of the old manual system were eliminated.

Lamson engineers have prepared a booklet called "Co-ordinated Control," explaining how conveyors and dispatch tubes can be made to integrate and co-ordinate production flow. You are sure to find it interesting. Send coupon for free copy.

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STRESS and STRAIN...

Then there was the dumb M.E. who ruined the mechanical calculator in the mech lab department when he divided a number by zero and burned out all the bearings.

* * *

She: If wishes came true what would you wish for?

He: I'm afraid to tell you.

She: Go ahead sap, what do you think I started this wishing business for, anyway?

* * *

"I can't see what keeps you girls from freezing."

"You're not supposed to, big boy."

* * *

An E.E. has invented a short wave diathermy appartus for cooking eggs inside the hen.

* * *

A male is a Boy Scout until he is sixteen; then he's a Girl Scout.

Physics instructor: "How do you get steam in a radiator?"

M.E.: "At home we just bang on the pipes."

* * *

He was calm and cool as he crossed the street, but it wasn't until the car hit him that he was collected.

* * *

Second (to boxer): "Well, old man, I guess you are licked."

Boxer (punchdrunk): "Yeah, I should have hit him in the first round when he was alone."

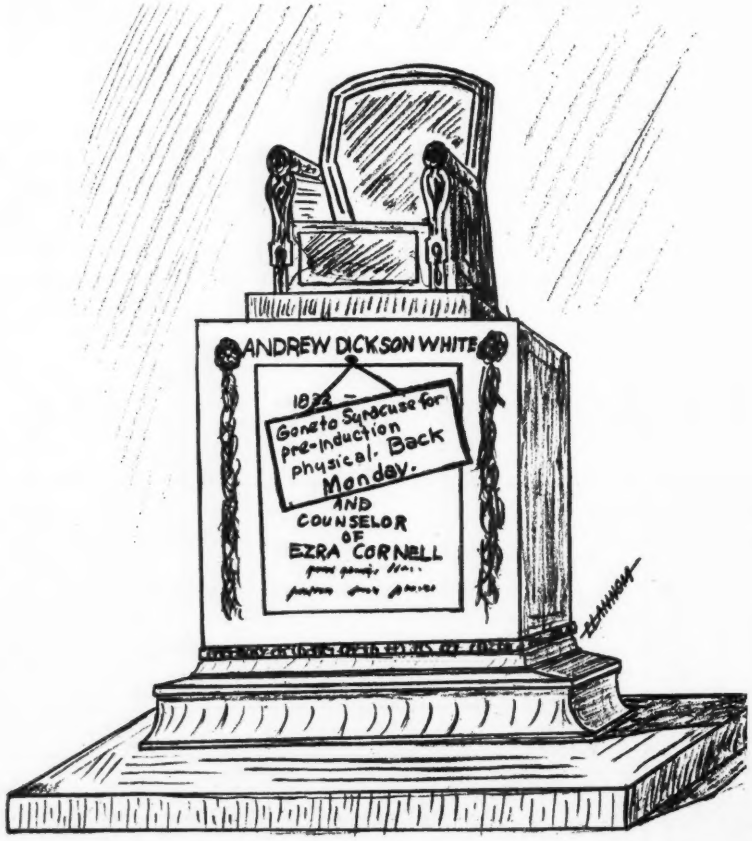
* * *

She: "Thanks for the hug."

He: "Oh, the pressure was all mine."

* * *

Late to bed and early to rise
Makes a man saggy,
Draggy, and baggy
Under the eyes.



Instructor: "You missed my class yesterday, didn't you?"

C.E.: "Not in the least, sir, not in the least."

* * *

Freshman: "Do you think late hours are bad for one?"

A.E.: "Yes, but they are fine for two."

* * *

NOTICE

A representative of the U. S. Army Corp. will be in Sibley Library on Sunday, June 4, from 5:30 a. m. to 7:30 a. m. to interview any students interested in securing immediate placement with the company.

Only "ex-quota" (unquote) students in engineering who plan to graduate after July 1, 1944 should apply.

Those chosen will be selected on a basis of high scholastic standing, since our company will employ only highly trained personnel. (Students who have received degrees from the Kavanaugh School of Physical Distortion need not apply).

All those interested should first obtain application blanks from Professor Crandall, Lincoln Hall (or Local 495, County Court Building), unless they have already received "Greetings" from the President of our corporation.

Note: Students with less than a 32 average in E. Theory will be given special consideration.

Practice for the "drill team" will be held afterwards in Barton Hall.

* * *

The British bar maid was a flirt, and when the corporal put down his beer and went out to buy a paper, she puckered her lips up to the young private and said, "Now's your chance, darling, go ahead." And the private seeing no one else in the place promptly drank the corporal's beer.

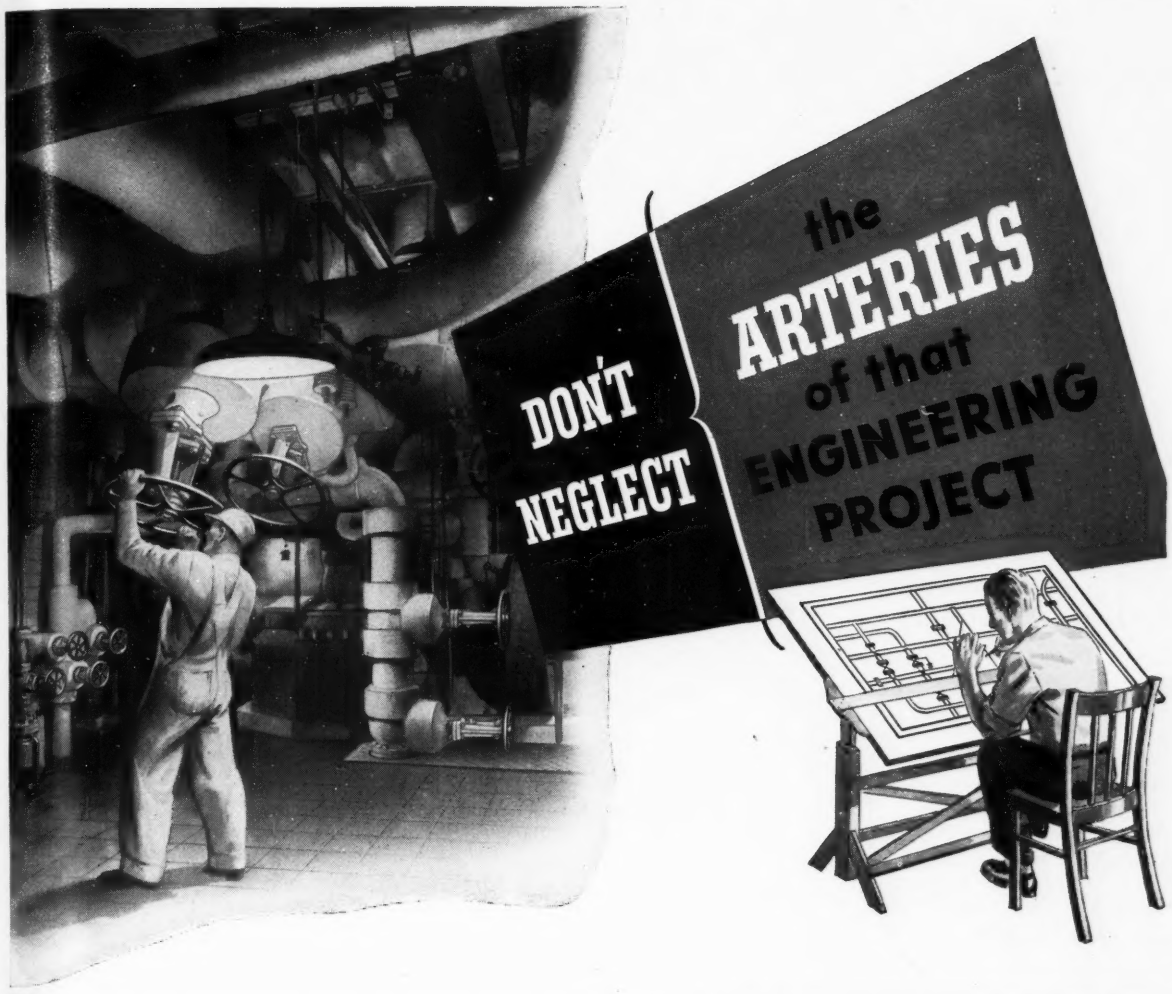
* * *

What foods we morsels be!

* * *

"Pop, what makes the world go round?"

"You little devil, stay out of that cellar!"



PIPING is an important part of almost every engineering project. When you indicate a pipe line on a drawing, think of it in terms of the pipe, the valves, the fittings, the unions, the traps that it will ultimately be translated into. Think of the metals of which it will be made—brass, iron or steel. Consider how it should be assembled—bolted, screwed or welded.

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